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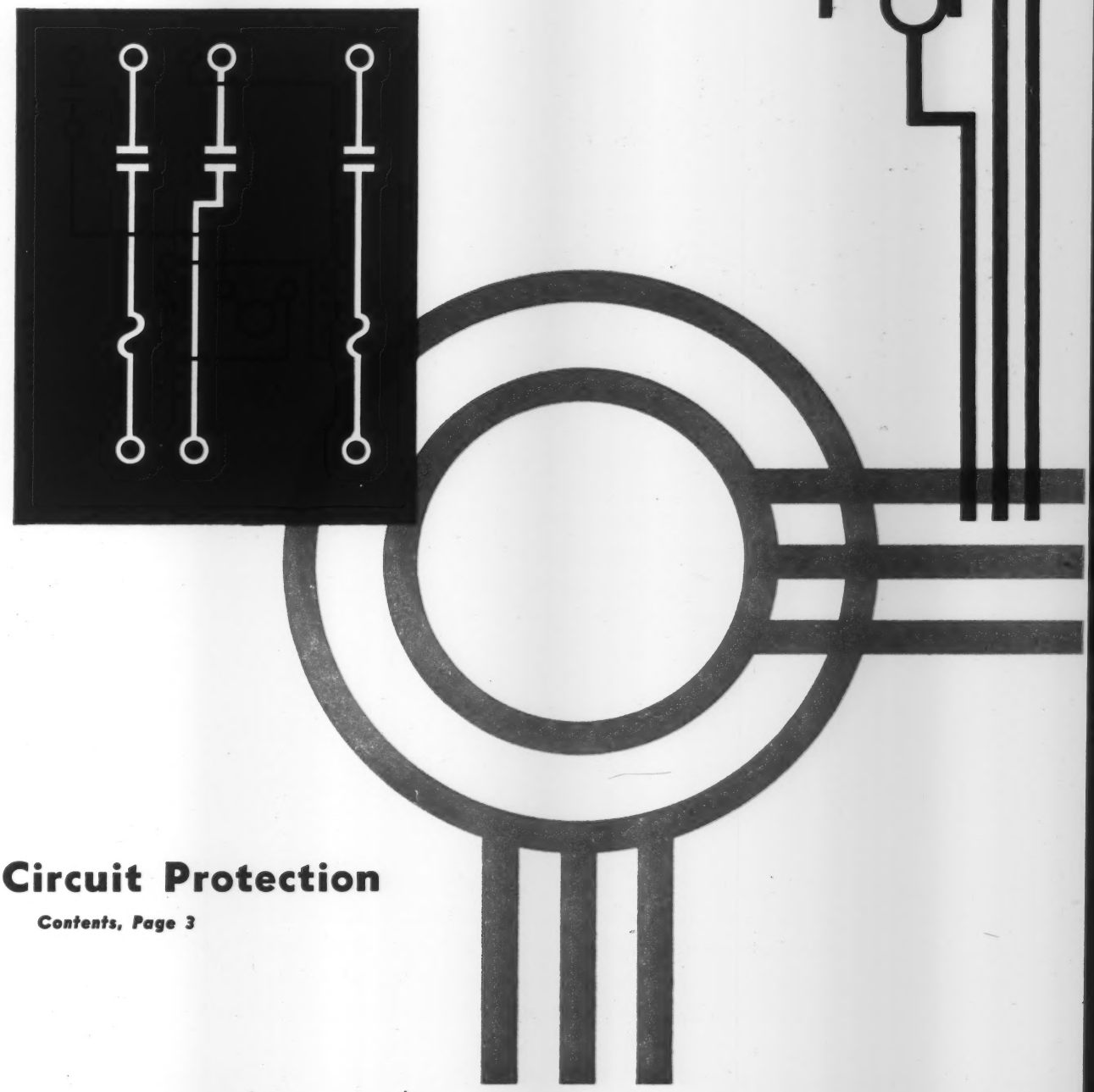

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Choice of the Leaders

CUTLER-HAMMER
MOTOR CONTROL
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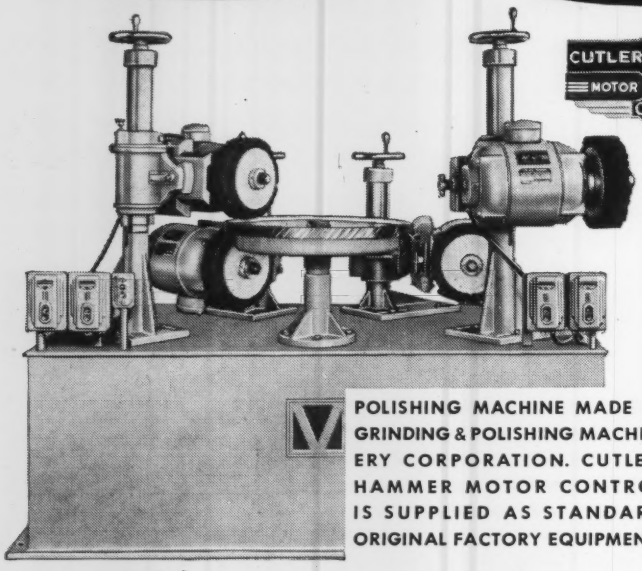
The Mark of Better Machines



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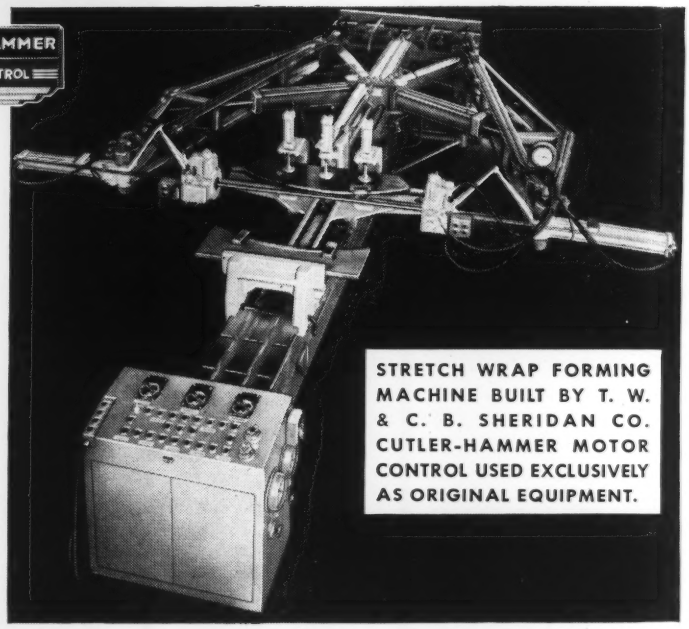

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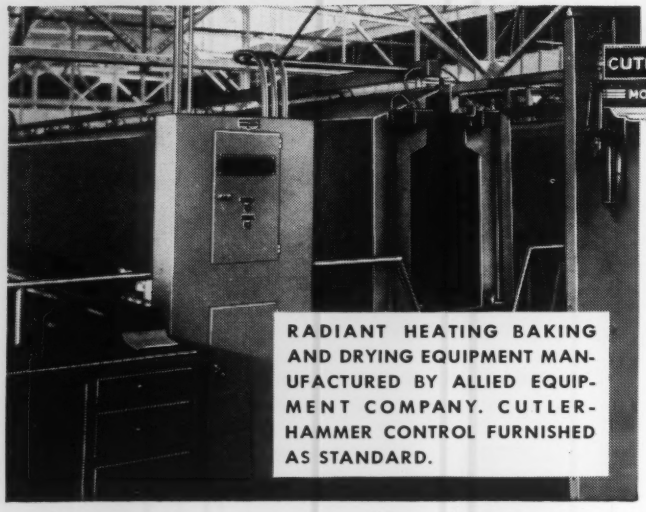

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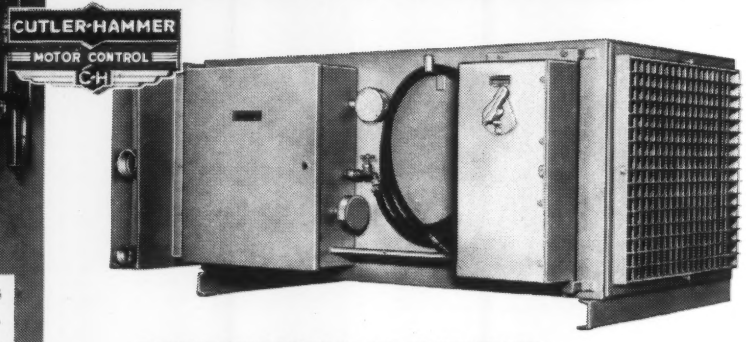

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Best by Test

In every division of industry, there are a few companies whose products are widely recognized as superior; by the test of direct competitive comparison these products consistently demonstrate a superiority of performance that sets them apart from all the rest. Such enviable position of leadership can be no accident but must result from a company policy of unrelenting product improvement and a jealous concern for every detail that influences the performance of the product in the field. Since these facts are so clear, what interpretation can be made of the fact Cutler-Hammer Motor Control is so frequently and continuously the choice of the nation's leading machinery manufacturers? Cutler-Hammer Motor Control *must* be a profitable choice for *you*. CUTLER-HAMMER, Inc., 1310 St. Paul Avenue, Milwaukee 1, Wisconsin, *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

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MACHINE DESIGN

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Over the Board

Your Favorite Feature?

As some of you know, representatives of the Daniel Starch organization have been interviewing readers of MACHINE DESIGN to determine the reaction to our advertising pages. In addition they have asked the question "Which editorial in this issue made the greatest impression on you?" We think you will be interested in the number of times some of the regular feature departments were mentioned over a period of 9 months. Here are the top five:

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If you were one of the 920 readers interviewed on these surveys, thanks a million for your co-operation. Your reactions help us in our planning—and your overwhelming votes for "Scanning" are vastly encouraging to Leo Spector, editor of this feature.

This Month's Cover

Good engineering is equally dependent on bold, imaginative concepts and on scrupulous attention to practical details. The tremendous power back of the electrical supply lines to a machine has a potential lethal and destructive energy which good detail design must anticipate. Experience has pointed the way to safe design of electrical circuits, which G. W. Heumann has very effectively presented in his article "Protecting Motor Circuits" beginning on Page 123. To complement the article George Farnsworth has related some of the circuit elements involved into a front cover design which we hope will perform the dual function of attracting attention to the article and highlighting an important area of MACHINE DESIGN coverage.

Listen to the Engineer

Commenting on the editorial "The Rise and Fall of an Engineer" (MACHINE DESIGN, February 1954) Richard Kessler writes: "It would seem that a man in an executive position would have an even greater opportunity to launch new projects within his organization, with the company's research facilities at his disposal to develop these ideas, than an engineer in a subordinate position whose ideas might possibly be rejected by an uninformed or unappreciative superior." Unfortunately that is the situation in some places today, and Mr. Kessler makes an excellent point in stressing the importance of giving the responsible engineer a status which will influence his management to listen to him.

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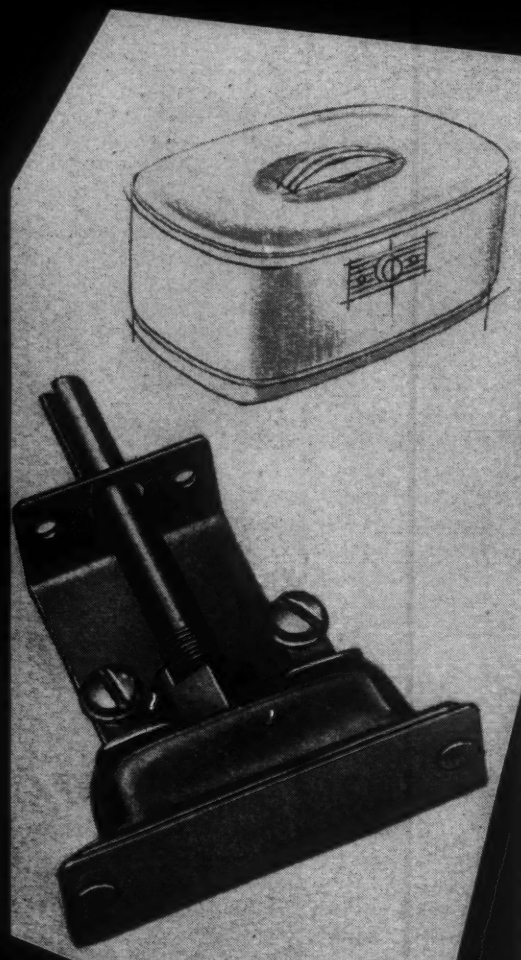

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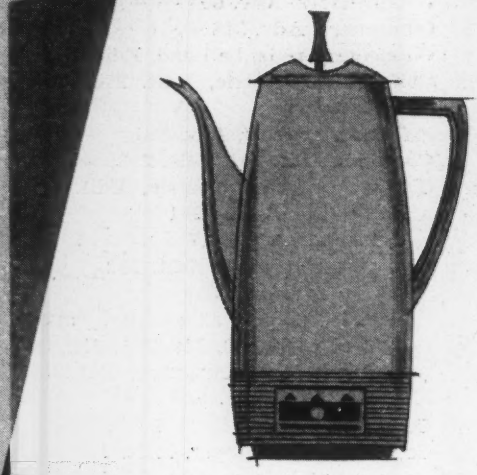
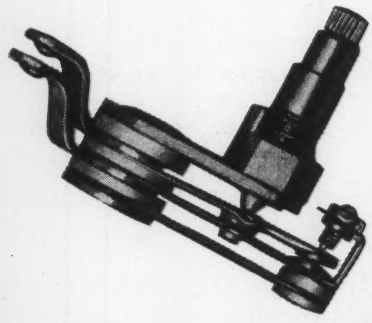
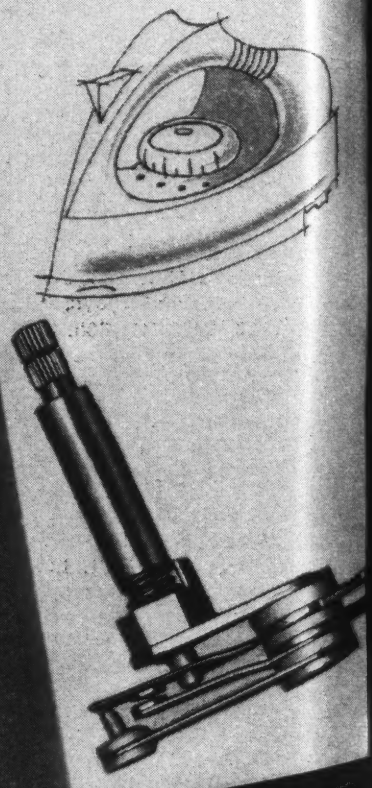
for portable roasters





TYPE SA
for automatic percolators



TYPE S
for steam or dry irons with multiple heats

THERMOSTATS

to whet a designer's imagination . . .

With competitive conditions ahead, you're probably reappraising your product. Or designing a new one. Either way, with Stemco thermostats on the job there's every chance you'll improve performance . . . solve production headaches . . . lower costs.

No other line of bimetal thermostats has as many different styles in production. So if you want close control, compactness, light weight—you'll find them all in Stemco thermostats. Combined with Stevens application engineering service, you profit from important savings of being able to use a production line Stemco thermostat for your special needs.

Let's match our experience and enthusiasm against an hour of your time. A card or call will bring our representative on the double.

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sensitive • close control
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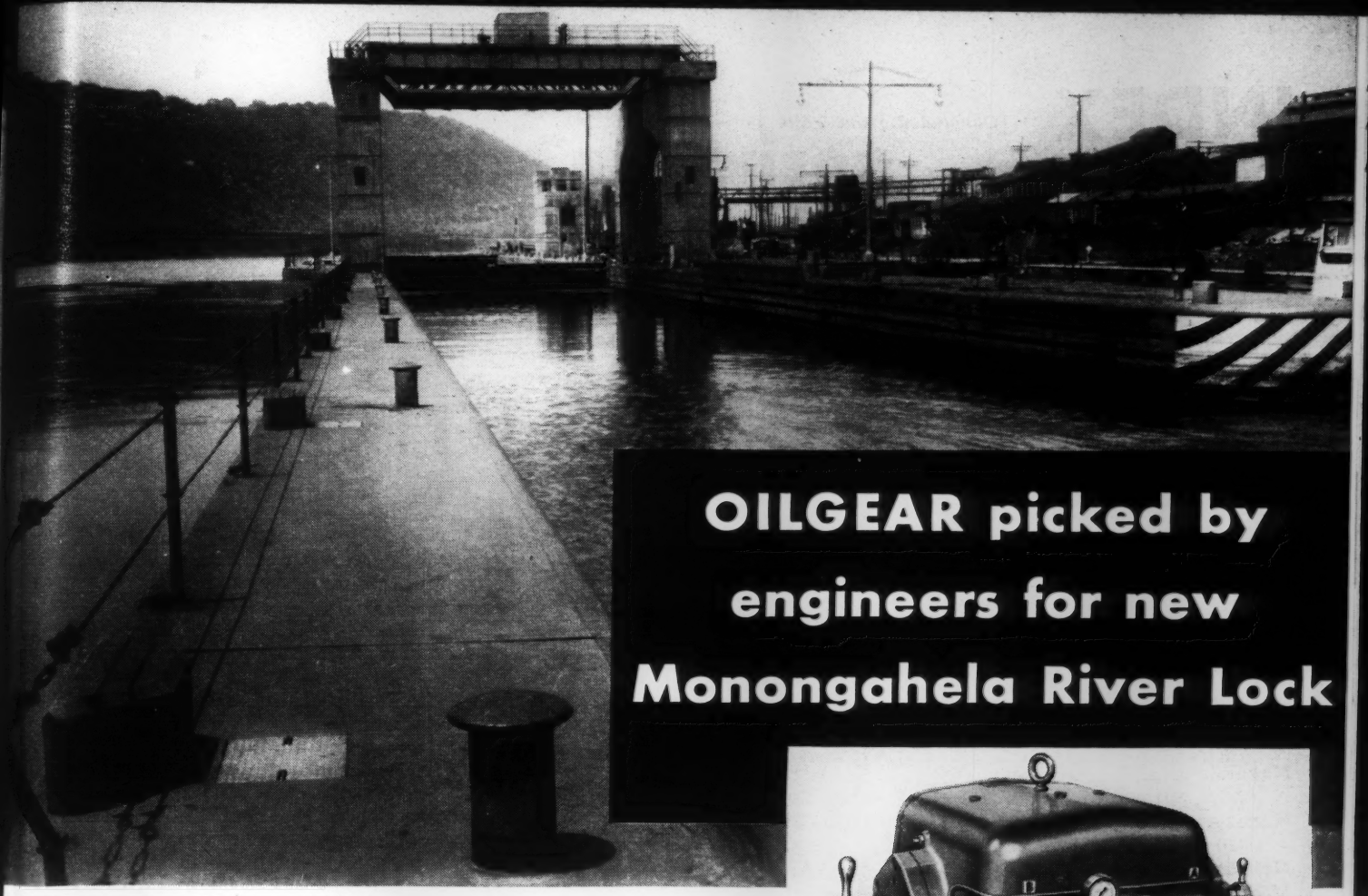
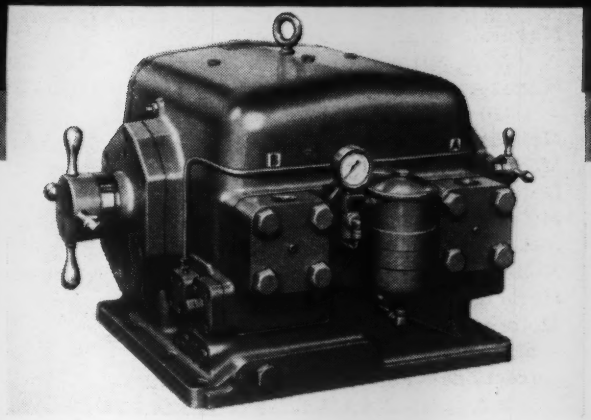


OILGEAR picked by engineers for new Monongahela River Lock

Photo courtesy Corps of Engineers, US Army



Oilgear Two-way Variable Delivery Pump with Electro-hydraulic Three-position Remote Control.

This versatile fluid power also used in McNary Dam and Bayou Boeuf Locks

The problem of selecting the power to operate the lock gates, butterfly valves and capstans in the new Monongahela River Lock was to provide the speed of operation, the capacity and the dependability that would keep the rapidly growing volume of shipping on the move. The river at this point now handles millions of tons more annually than Panama.

Certainly, in the fact that Oilgear Fluid Power equipment was selected for this lock, as well as for those at McNary Dam in Oregon, and at Bayou Boeuf in Louisiana, is evidence of the repute in which Oilgear is held.

But we are inclined to stress the *versatility* of Oilgear Fluid Power . . . its applicability to a wide range of needs ranging from the impressive capacity required for lock operation . . . to the delicate and assured precision, controllability and accuracy required in printing on flimsy cellophane . . . and to the middle ground of industry where production must always be increased and always kept on the move.

Fundamentally there is no difference. There must be power, *ample* power, susceptible of control some times rushing and gigantic, some times a mere whisper of power whittled down to a point, as it were.

With Oilgear Fluid Power available in pump and cylinder for straight line motion, or in pump and motor or integrated transmission for rotary motion or reduction of ratio, you have a power source and method applicable to any need. In addition, you gain ability to vary speed or power steplessly in an extremely broad ratio. You can have power that does not move but simply holds a member under constant pressure. You can have speed that clings closely to the changing viscosity of a beaten mass... or power that forms giant airplane fuselages and wings.

Whatever your problem, it deserves the opportunity to be matched with Oilgear versatility for a better solution. It will cost you nothing to investigate. It may show you a tremendous gain. THE OILGEAR COMPANY, 1568 W. Pierce St., Milwaukee 4, Wisconsin.

OILGEAR

OILGEAR

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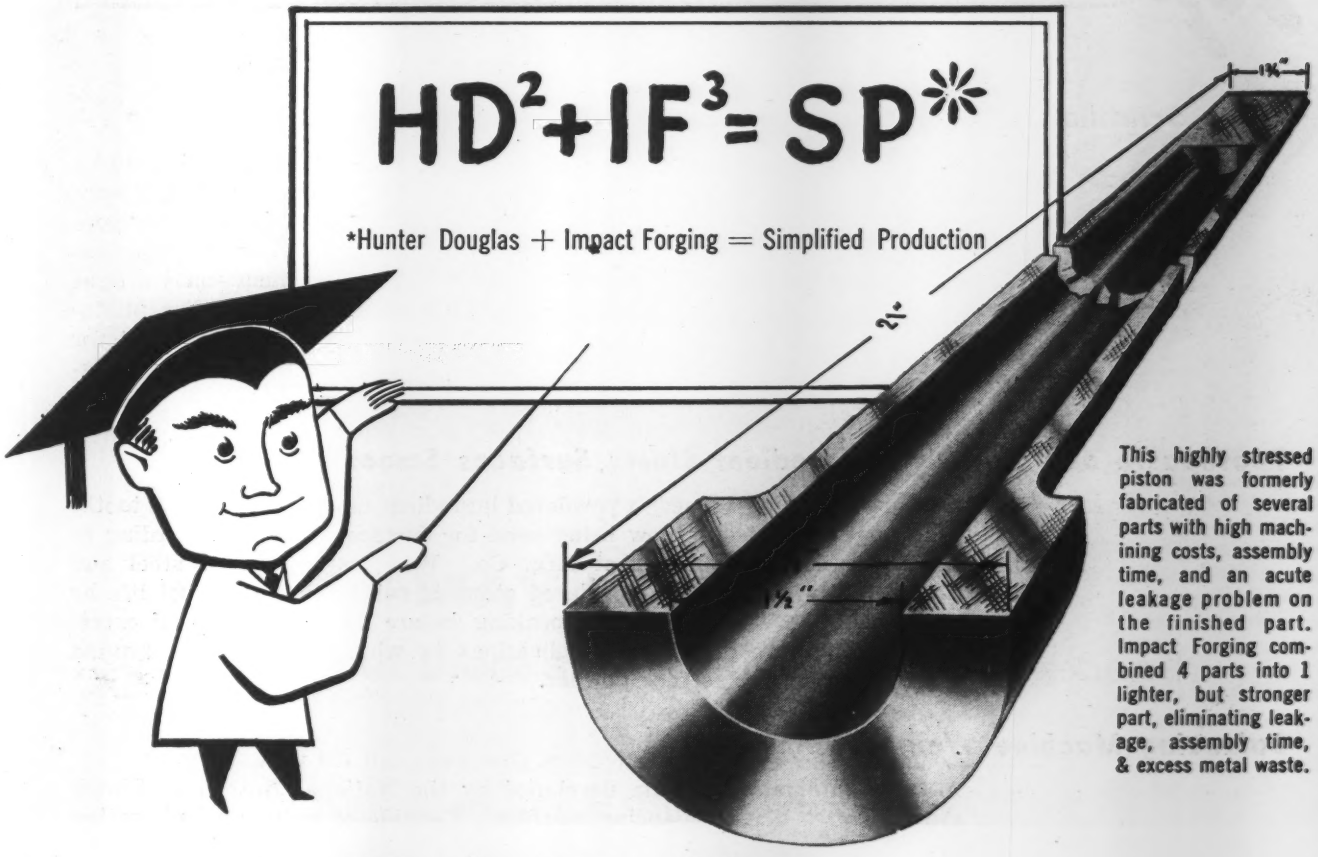
Mr. Design Supervisor

...an equation you should know



This highly stressed piston was formerly fabricated of several parts with high machining costs, assembly time, and an acute leakage problem on the finished part. Impact Forging combined 4 parts into 1 lighter, but stronger part, eliminating leakage, assembly time, & excess metal waste.

You can simplify design with...

IMPACT FORGING

FROM

HIGH STRENGTH ALUMINUM ALLOYS

Impact Forging is a mass production method of shaping high strength aluminum alloys by direct compression. This new production technique, perfected by Hunter Douglas, permits the use of heat treatable aluminum alloys in applications formerly designed to steel. Combined with the strength-weight ratio of aluminum, Impact Forging develops a forged grain flow to obtain maximum strength in each part.

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MACHINE DESIGN

Topics ...IN ENGINEERING AND RESEARCH

Alpha Scintillation Poppy Keeps Atomic Workers Hoppy

Called the "Alpha Scintillation Poppy," a new device for detecting alpha contamination on clothing and in laboratory areas uses a scintillation technique. Often used with registering devices which give an audible "popping" signal—explaining the reason for its unique name—the Poppy announced by GE consists mainly of a phosphor screen which emits a light flash when struck by an alpha particle and an electron-multiplier phototube which detects the light flash and sends a pulse to scaler circuit for "totalizing." The Poppy, which weighs only 2 pounds 6 ounces, is insensitive to beta and gamma radiation.

Toothpaste and Cosmetic Ingredient Blasts Surfaces Smooth

"Arkansas Honing Stone," a powdered ingredient originally added to toothpaste and cosmetics, is now being used for surface finishing, according to A. P. Neumann, Vapor Blast Mfg. Co. Wet-blasted against steel and carbide cutting tools, the powdered stone is said to increase tool life as much as 50 to 70 per cent. Speaking before the ASTE annual meeting, Neumann told of some applications in which the stone is ground three times as fine as face powder.

Balancing Machine Weighs Coins

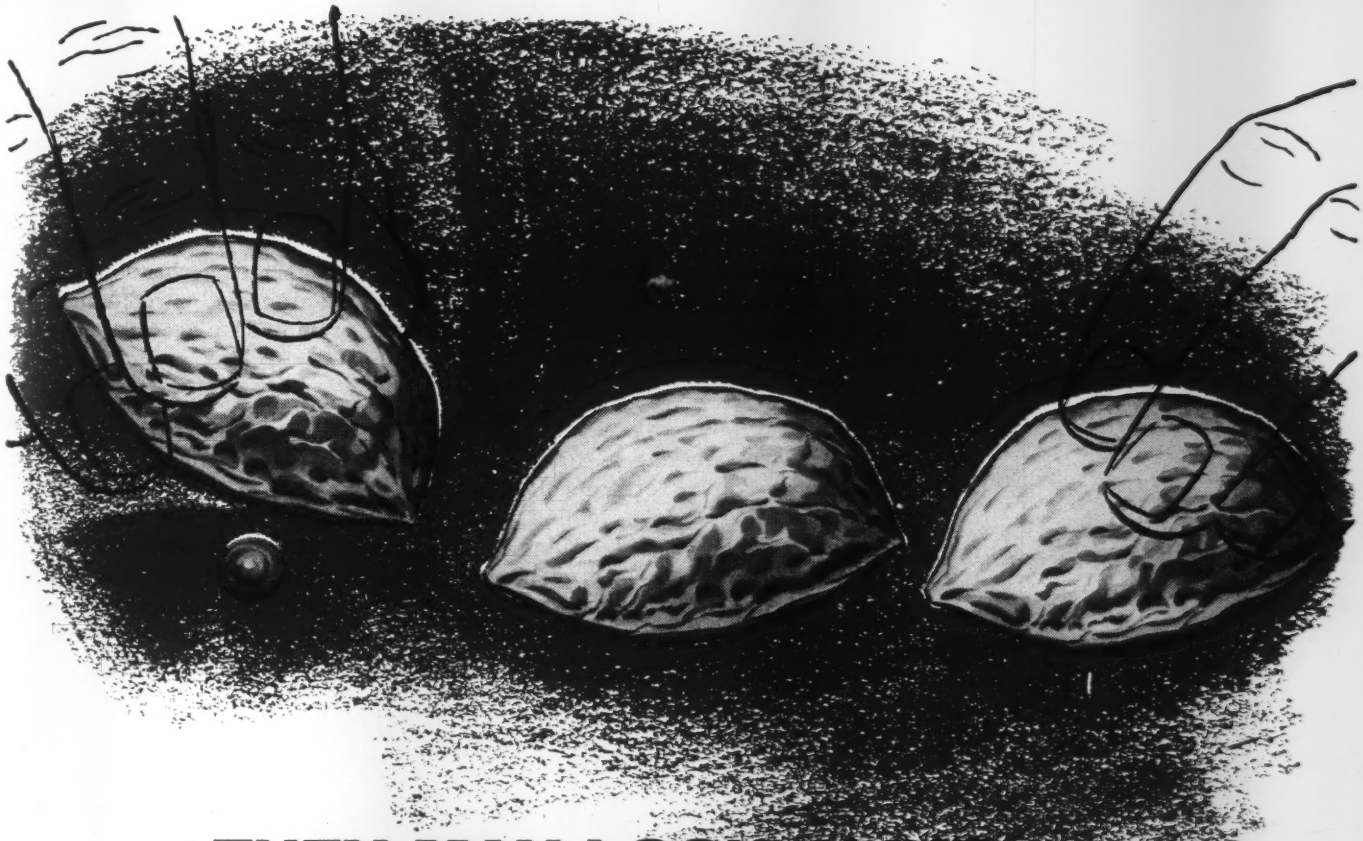
A fully automatic machine developed by the National Bureau of Standards operates like a balancing machine. Capable of weighing and sorting 18,000 coins an hour, the machine weighs coins by measuring the degree of unbalance imparted to a rapidly revolving flywheel into which two coins, the standard and the one to be weighed, are placed. Sorting of coins into "light" and "heavy" categories is accomplished by ejecting the coin from the flywheel at a precise angular position. Injection of coins into the wheel is accomplished through a hole in the wheel hub by means of a solenoid, the coin then traveling to the outside edge by centrifugal force and forcing the already weighed coin off the wheel.

Aluminum Screen Provides Electrical Shielding

Aluminum wire screening with neoprene-filled interstices is now being used for electrical shielding in electronic equipment. According to Vulcanized Rubber and Plastics Co., high conductivity, dimensional stability and resistance to deterioration are chief advantages. Both surfaces are buffed to insure uniform gage and to expose the aluminum wire so it will make good electrical contact. Thickness of 0.02-inch is standard in cut gaskets or uncut sheets.

Free-Fall Quench Process Eliminates Distortion

A new quenching method for solution heat-treated aluminum aircraft parts is said to eliminate distortion caused by conventional quenching methods. Customarily, as reported by the Glenn L. Martin Co., aluminum parts are placed in a basket which is immersed in a molten salt bath. The hot basket and parts are then lowered into a running cold water bath for quenching. As the basket comes in contact with the quenching bath, a mixture of steam and water droplets is generated. Droplets striking the aluminum parts are vaporized, absorbing heat locally and causing dis-



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tortion. With the new method, parts are dropped from an overhead conveyor into the bath, and are quenched almost instantaneously, reducing distortion by as much as 90 per cent. A basket previously placed in the bath is used to remove the parts.

Spot Welding Saves Scrap Titanium

By resistance spot welding a thick stack of scrap titanium, a solid ingot of virgin metal can be formed which is at least as strong as the parent metal. The method of spot welding, developed by the Martin Aircraft Co., involves the use of a liquid cooling bath in which the scrap sheets are welded. By carrying off welding heat, welding machine capacity is said to be increased six-fold. Stacks of titanium sheets up to 6 inches thick can be welded, and stainless steel up to 3 inches thick. Welded "ingots" are machined into titanium hardware and aircraft parts.

Gas Turbines Step Forward for Railroads, Engineer Says

More power in a smaller package for railroads is offered by gas turbines, according to Frank Fahland, general mechanical engineer, Union Pacific Railroad. Speaking before the American Power Conference held recently at Illinois Institute of Technology, Fahland said that gas turbines are one result of a continuing search by railroads for methods of pulling more tons at greater speeds without corresponding increase in cost of investment and maintenance. Ten gas-turbine locomotives currently operating in freight service for Union Pacific are said to outperform comparable diesel locomotives at speeds of 20 to 50 mph.

"Hypodermic" Thermocouple Measures Atomic Reactor Temperatures

Consisting of an insulated constantan wire in a tiny Inconel tube, a new thermocouple developed at Argonne National Laboratory can measure temperatures to 1250 F in an atomic reactor. The thermocouple is manufactured by inserting the wire into Inconel tubing of hypodermic needle type, and drawing the tube through a die, causing the tubing to grip the wire tightly. Fabrication is completed by fusing the wire and tubing at one end. Sensitivity is very high, since the thermocouple is only 0.040-inch in diameter and a protective tube or enclosure is not needed. Thermocouples 20 feet long have been constructed.

New Abrasive Material Looks Like Window Screen

Designed for sanding operations where loading or glazing is a problem, a new open-mesh abrasive material developed by Carborundum Co. looks like window screen. Consisting of material coated with silicon-carbide grains, "Sand-screen" can be used flat or folded, and can be creased and torn to desired size. Sanding residue flows freely through the openings, and the material can be used with metals, wood, and paint undercoats and sealers.

High-Speed Technique for Producing Transformer Coils

Wafers produced by rolling together thin metal foil and insulating paper are key elements in a high-speed automatic transformer production method developed by Sylvania. Traditional method for producing electronic transformer coils involves winding copper wire on cardboard cores. In the new method the coils are made by rolling wide sheets of foil and paper into a thick-walled tube, then slicing the tube like a jelly roll. Each of the slices, or wafers, can be part of a transformer stack or, for radio and television frequencies, may actually be the complete transformer.

MACHINE DESIGN
JUNE 1954

Too Little or Too Late?

ENGINEERING faces an era of the fiercest competition it has ever known. Not only must equipment and appliance manufacturers have well-designed products with which to fight for their share of a buyer's market, but our nation's best hope of averting a military showdown with an implacable enemy is to maintain technological superiority in weapons.

Recognition of these cold facts has focused attention on the need for attracting and holding topnotch engineering talent. The continuing urgency of the situation has prompted several studies out of which have emerged a few concrete findings. If acted upon, some of the recommendations will result in lasting benefit to the engineering profession.

Two of a number of conclusions brought out at a recent National Manpower Conference at Columbia University deserve special notice by engineering management:

> Engineers have to have the best tools and instruments, as well as good supporting personnel, if they are to make efficient use of their training and talents.
>
> Improved utilization can also be achieved by keeping technologically trained people at the technological jobs for which they are best fitted through incentives in the form of status, recognition, and money rewards which are generally associated with jobs in management and sales.

Because design engineering is creative, the "best tools" must include an environment conducive to mental effort. Fundamentally, therefore, the two conclusions cited involve simply those elements that contribute most to a man's pride and satisfaction in his job—a good place to work, adequate facilities and help, a feeling of importance and some tangible recognition for a job well done.

While some managements have gone far toward meeting those basic human needs, it is a sad reflection on the others that neglect of them is so prevalent as to impress an independent group like the National Manpower Council. It is fervently hoped that further action will be neither too little nor too late.

Colin Carmichael

EDITOR

Practical Production Tolerances

.. in the design of electric timing units

By Warren J. Grosjean
Quality Supervisor, Telechron Dept.
General Electric Co., Ashland, Mass.

BEFORE truly economical control of quality can become a reality, the capabilities of equipment and processes must be known, and those attributes must be kept in mind in design. In the production of Telechron products, *Fig.* 1, these suggested principles have been exploited in recent years to the great advantage of both performance and quality of the product.

The field of application of these common-sense ideas was quite fertile at Telechron Dept.; products are almost miniature in nature, and quantities are high in a rather diverse line of products. Total parts per year exceed one billion; 8100 different components are produced for more than 192 different assemblies.

Approaching the Problem: Obviously it is impractical to design for a process or try to control the quality in that process if it cannot do the required job. Alternatives are sorting or jobbing, operations that usually prove expensive in the long run.

Perhaps the first requisite for a program aimed at the improvement of such conditions is a healthy spirit of co-operation by all branches of the organization—design, methods, tooling, production, quality control, etc. As examples will reveal, action by no single group can produce the improvements that are achieved by the interlocking of efforts of all groups involved.

The best starting point in an attack of the problem usually is a study of the capability of manufacturing processes. Such work can be conducted by personnel without special statistical training, although obviously a sound engineering footing is most helpful. The requirements of the job are simply:

1. Time
2. Common sense
3. Knowledge of how to picture a process at a given instant
4. Knowledge of how to determine the effect of time on a process.

The first of these requirements—time—is a matter of company policy. It is usually better to spend a little time trying to find out beforehand what can be done, than it is to spend more time later trying to do the impossible.

The second—common sense—is important in analyzing the results and correct action to be taken.

The third—how to get an instantaneous picture of the process is accomplished by the use of a frequency distribution chart such as shown in *Fig.* 2. This chart is simply a method of picturing what a process is doing by plotting the frequency of occurrence of each measurement of a particular characteristic. The only technical part of this job is the calculation of the probable extremes of the variation as demonstrated in *Fig.* 2.

The fourth requirement—knowledge of how to picture the effect of time on a process—can be done by any of several methods. But the easiest and certainly the most understandable is the simple dot type control chart as pictured in *Fig.* 3. (Other types of control charts may be necessary in certain operations but they have been discussed elsewhere[1] and will, therefore, not be discussed again here.)

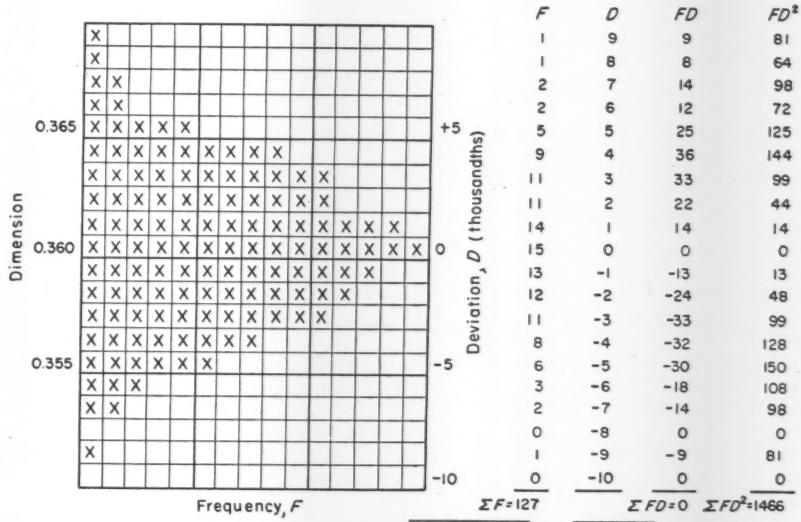
1. Dorian Shainin—"Quality Control Methods—Their Use in Design," MACHINE DESIGN, July 1952 to May 1953. Also available as a reprint.

Fig. 1—Type of manufacturing operation in producing parts for an electric timer (insert). Quality control studies aided in establishing tolerance specifications that could be met by available equipment

In general, machine capabilities may be obtained as follows:

1. Take about five machine capability studies of the process in question at different times. (Frequency distributions of about fifty pieces of product all made at the same time.)
2. Examine each distribution to see that it is normal, i.e., resembles a bell-shaped curve, *Fig.* 2, and is not bimodal as in *Fig.* 4
3. With the simple formula shown in *Fig.* 2, calculate the variability of the process if its curve is normal
4. Calculate the average variability found in all machine capability studies
5. Run dot type control charts to learn if any factor has been overlooked, and the effect of time or tool wear on the process. If time or tool wear are factors, their effect plus an allowance for set-up error should be added to the average variability to obtain a workable tolerance.

If, under step 2, there were some stragglers, or the distributions did not have the general shape of a bell, *Fig.* 4, it is necessary to analyze the process carefully to learn what is wrong (something usually is), and make any necessary corrections. Cor-



F	D	FD	FD^2
1	9	9	81
1	8	8	64
2	7	14	98
2	6	12	72
5	5	25	125
9	4	36	144
11	3	33	99
11	2	22	44
14	1	14	14
15	0	0	0
13	-1	-13	13
12	-2	-24	48
11	-3	-33	99
8	-4	-32	128
6	-5	-30	150
3	-6	-18	108
2	-7	-14	98
0	-8	0	0
1	-9	-9	81
0	-10	0	0
$\Sigma F = 127$		$\Sigma FD = 0$	$\Sigma FD^2 = 1466$

Normal maximum variation = $6\sigma = 6\sqrt{\frac{\Sigma FD^2}{\Sigma F} - \left(\frac{\Sigma FD}{\Sigma F}\right)^2} = 6\sqrt{\frac{1466}{127} - 0} = 20.3$

Fig. 2—Frequency distribution chart showing the number of times (frequency) pieces are produced to the dimensions indicated. Tabulation shows how the normal maximum variation is calculated from the deviation, *D*, and frequency *F*

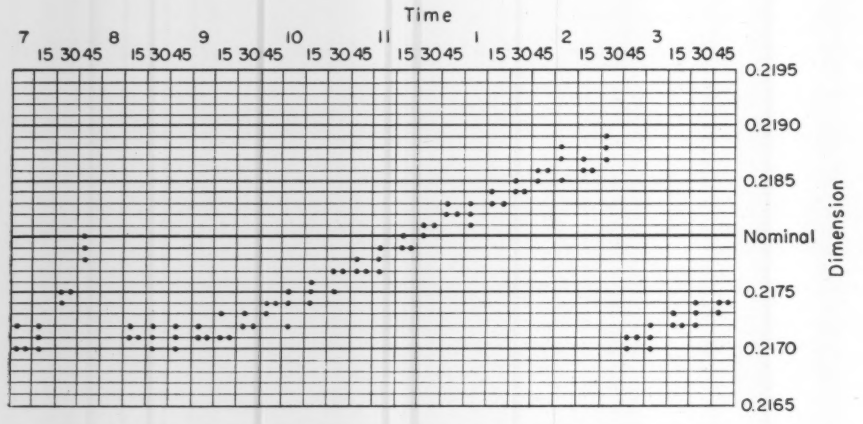


Fig. 3—Dot type control chart showing the dimensions produced by a machine during a working day

rections must be made before any workable tolerance can be established.

This, then, is the general method of approach. But what has been the actual attack and what results have been attained in specific instances? The following are a few actual case histories of the application of this approach to the problems of workable tolerances in several operations at Telechron Dept.

An Assembly Problem: Components made in screw machines, punch presses, molds, etc., are joined to form basic subassemblies which in turn are later assembled on a conveyor to form an end product such as a clock or timer. The components are joined by the use of kick presses, staking presses, riveting machines, or occasionally welders. These operations determine certain quality characteristics such as tightness and location which often are quality problems. Capability studies of the equipment are frequently employed to define the nature of a problem, i.e., whether it is one of excessive variability or one of proper machine setting, *Fig.* 5. If, as in *Fig.* 5*a*, the problem is only one of proper machine setting, the setup man can readily correct and stop the production of defective product.

However, if the problem is one of excessive variability, *Fig.* 5*b*, the solution must be found by others. The process capability studies do not tell what must be done for correction—only the type of corrective action that is necessary; engineering knowhow must in the last analysis arrive at the proper corrective action.

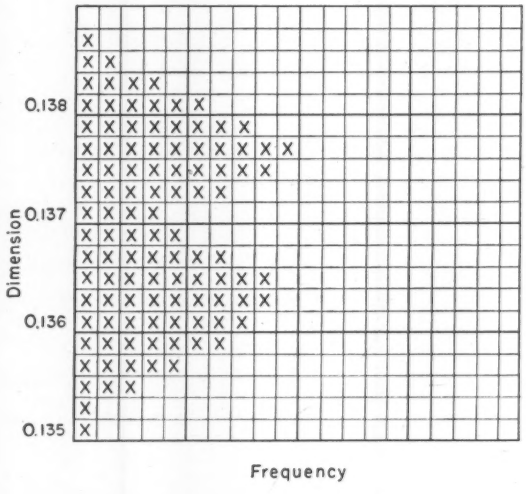
An example of where a subassembly quality problem may lead is provided by the minute-hand friction assembly, *Fig.* 6. This is the clutch in the clock that slips to permit the hands to be set. The problem arose from the difficulty of meeting the friction limits. These limits must be met because low friction means hand slippage and high friction makes setting difficult.

Before the statistical investigation of the minute-hand friction assembly started, a 100 per cent sorting operation was required to make sure that no defective units reached the market. This, plus scrap cost, amounted to about 50 per cent of the cost of the assembly. Frequency distribution studies showed the variation to be greater than the tolerances. Obviously, therefore, the sorting operation was a must until the cause of the variation could be discovered and corrected. Guided by machine capability studies, the investigators worked from the raw stock and the punch press operations through to the finished assembly. The nature and extent of the job are evident from the following list of changes:

Design Changes

1. New tolerances were established on the raw material used in the friction spring, to reduce the variation in spring force.
2. A new specification was determined for the spring—a specification consistent with the end use and the forming capability.
3. The hole in the spring was changed for better assembly.

Fig. 4—Frequency distribution chart which is not normal. Compare this bimodal shape with the normal bell shape of *Fig.* 2



4. Different material was used in the gear to reduce the friction variation.
5. The shoulder length of the pinion was changed to provide adequate material for staking.
6. Extra washers were added to the assembly to make a smooth friction.

Inspection or Control

7. A new test method was set up for the process inspection of the friction spring, to duplicate properly the use of the spring in the assembly.
8. Operator control charts were put on the punch press to help meet the spring specifications.
9. An inspector-maintained control chart was established to control the machine variables and assure that the assemblies are made to specifications.

New Tooling

10. A special stock prebender was designed for the spring stock to eliminate the need for more than one die and compensate for changes in stock thickness.
11. Special staking tools were designed to provide a tight staking and reduce oil-canning of the spring and the resultant torque variation.

The foregoing changes resulted from the studies made by the investigators using frequency distributions to indicate what steps would prove effective and in what direction future efforts had to be made.

The result of these changes was that the friction assembly could be made to specifications and the sorting and scrapping of assemblies were discontinued at a saving of about $20,000 per year.

Automatic Screw Machine Parts: The first large-scale use of frequency distribution and dot chart studies to learn the capabilities of machinery and set standard tolerances for our products was made in the automatic screw machine section. The method of attack was simple enough. Frequency distribution studies were taken of each characteristic—knurl size, overall length, diameter of forming, etc.—on different parts using different stocks and various machines. After about 500 studies were taken the data were grouped and analyzed. The effect of stock diameter on knurl size was analyzed as was the effect of material on the variation in formed diameters. The analysis was, in general, done by grouping like data, discarding the obvious strays (those whose variation was not consistent with the remainder of the group and could possibly have been caused by improper machine maintenance or set up), and calculating the variation that would include 99 per cent of the probable variation.

With the basic machine capabilities now established, an attempt was made to establish the effect of time on each of the characteristics by the use of dot charts. These charts showed the effect of wear on the form tool dimension as well as the effect of particular materials on the wear rate of various tools.

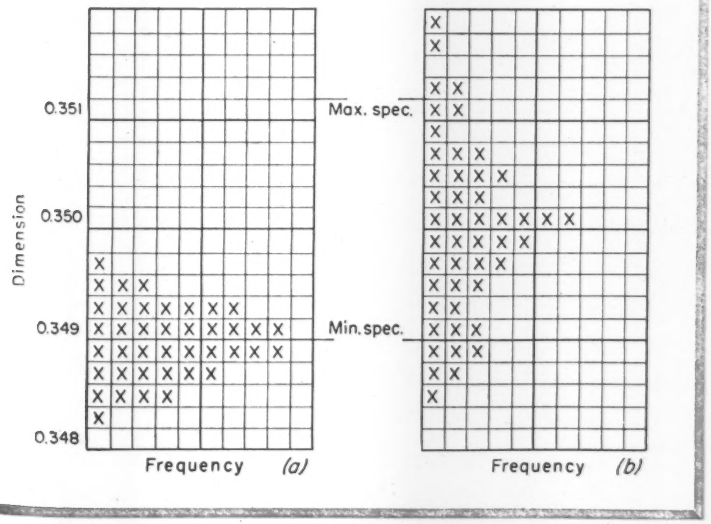
When all the studies were completed, the tolerances for the various characteristics were established as equal to that necessary to encompass 99 per cent of the normal variability at any one time plus a factor for tool wear. For example, the tool wear factor for forming was determined to be 50 per cent of the process capability and it was added to the process capability to establish the standard tolerance. The factor for error in setting up was not included in the standard tolerance because it is allowed for in the particular sampling plan applied to each particular part in the acceptance of the part.

Based on the foregoing, standard production tolerances were established and agreed to by both engineering and manufacturing as being the minimum tolerances that would be specified by engineering unless there was a specific and definite need for tighter tolerances, in which case special machinery would have to be purchased. These tolerances were written up in special standard instructions to be used on all screw machine parts.

These tolerances have been in use for about five years now and have proved their value. No longer is there any question whether screw machines can meet the specified tolerances. And no longer is it necessary for the inspector to set his own specifications on a part. Even more important, the designer has a better basis on which to build his designs. Better products must result.

Hobbed Gears: Upon the successful completion of the screw machine standards program, it was thought advisable to turn attention to another basic operation. A problem, which may sound familiar to many, was present in the section where gears are hobbed for clock motors. The condition, as it existed, can best be described as a quality bottleneck. On this job there were as many in-

Fig. 5—Frequency distribution charts showing *(a)* improper machine setting and *(b)* excessive variability



spectors as there were hobbing machine operators; there was a large backlog of work to be inspected at all times and there was also a high percentage of scrap. The questions were, what should be done to

1. Relieve the bottleneck?
2. Reduce the inspection cost?
3. Reduce the cost of waste?
4. Improve the quality of the gears?

The answers were certainly not obvious, but the indications were that the procedure followed in the screw machine section could help find the answers. Therefore, a small group was organized to find the solution. Many hours of observation and study were spent on the job. Experiment upon experiment and frequency distribution upon frequency distribution were made to try to define the exact problem and correct it.

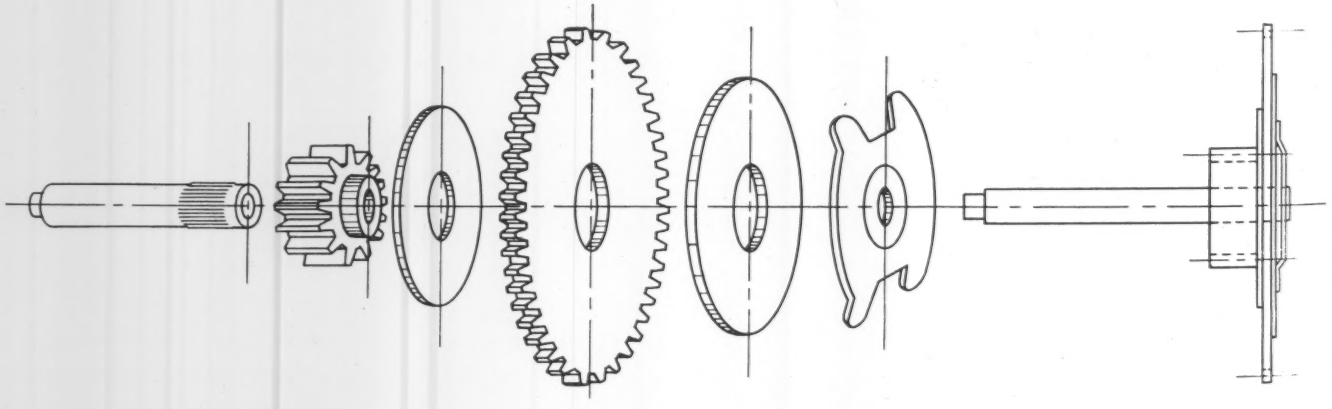
Because the gears are top hobbed (the entire tooth shape is hobbed) it was determined that an inspection of the OD of the gear was sufficient to prove the gear good with only an occasional check for tooth form. The problem then boiled down to one of controlling the OD variation.

One set of studies early in the program proved that the OD was a function of the location of the gears on the arbor (*Fig.* 7) and that they could be inspected before removal from the arbor. This greatly increased the speed and accuracy of measurement. Another set of studies proved that the end three gears were frequently defective and should be segregated from the remainder of the gears. It was also found that the gears varied in size on the arbor as well as from one arbor to another. Repeated studies traced this to a variation in the tightness of the arbor stack caused by variation in the tightening of the tail stock and also to improper alignment of the centers. The first was corrected by a hydraulic tightening device and a redesign of the arbors and the second was simply a matter of machine setup.

Now the experimenters were ready to find out what really could be expected of the process. Their studies showed that the machine capability in the hobbing of the OD was about 0.0010-inch and the effect of time and stock variables increased this to about 0.0015 inch. Reanalysis of the design, in the light of anticipated control of the process, led to the conclusion that the tolerance could be increased from 0.0010-inch to 0.0020-inch without affecting the functioning of the motor.

With the foregoing modifications in process, and with proper specifications, it was possible to reorganize the method of inspection and break the quality bottleneck. Now, every operator inspects her own work patrolled by one inspector. Better gears are being made, with much less machine down time for resetting to try to meet an impossible specification. When one considers that one inspector controls the production of hundreds of thousands of hobbed gears per week with an aver-

Fig. 6—Minute-hand friction assembly which required design changes, as well as new inspection and tooling, to bring friction tolerances within specification and permit quality control. Resultant savings amounted to $20,000 per year



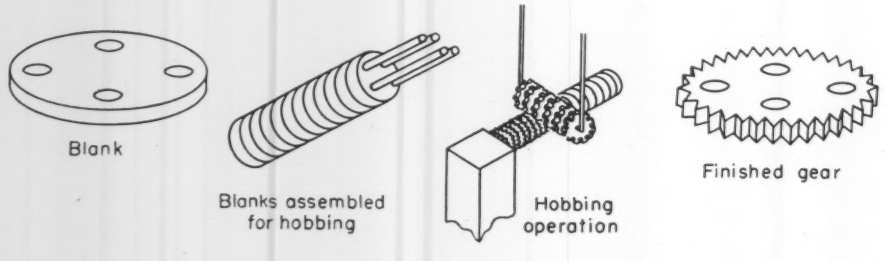


Fig. 7 — Location of clock motor gear blanks on arbor for hobbing. More liberal tolerances, fully controlled, permitted production of better gears with less machine down time for resetting to meet an impossible specification

age outgoing quality level of better than 99.9 per cent good—as against 15 inspectors, and much scrap—some idea is suggested of the saving that has been achieved.

Stampings: With the last two problems under adequate control, the punch press section was tackled next. Hard experience many years ago proved that any timing unit wherein levers were used was far more variable than general standards would permit and consequently was something to be avoided. It was felt that only rotational motion of the gear or cam type could do the job that was required. Since the war, however, designs which can perform prodigious tasks with a very resonable cost have been proposed. But, in general, these designs call for the use of many bent and formed parts and rely heavily on lever action instead of cam action. The overall customer value picture is excellent for these designs but a big problem early became evident. Can these levers be made to the design specifications? Can they be made to perform properly? The obvious answer, "no", was hard to give because of the enormous advantages and possibilities in the use of lever action.

This time the method of attack was broadly evident. Statistical studies of the type used to set screw machine and hobbing standards seemed to be the tool for obtaining a solution. The start was made on a pilot run basis. Individual parts already in production were selected, not those causing little trouble, but the really troublesome items. The start was made on a vibrator, *Fig.* 8, which is a ¾-hard cold-rolled steel lever containing numerous bends. To obtain proper alarm tone and timing, a relationship must be maintained between the ends in spite of the number of bends between ends.

Early in the course of the studies it became evident that the variation in each characteristic (location of bends, angle of bends, etc.) was so great that it would not be possible to specify each characteristic from a production point of view and still have a part that would function properly. A careful review of the studies showed that certain specifications could be set on the part which would be met by production and which would result in a usable part. This was done by specifying the required end dimension directly instead of letting it be the sum of several other unimportant dimensions, and their variations, *Fig.* 8. This, together with gages designed to measure the part exactly as it will be used, has made possible the production of vibrators that will work exactly as required. Called functional dimensioning and gaging this method has been found to be not only a great help but a necessity for the type of manufacture embodied in the new designs.

The foregoing experiment and many others of a similar nature and result led us to believe that overall conclusions could be obtained and a set of standard tolerances on punch press parts could be written. Therefore, an overall program was set up with a committee representing design, production, and quality control to follow the execution

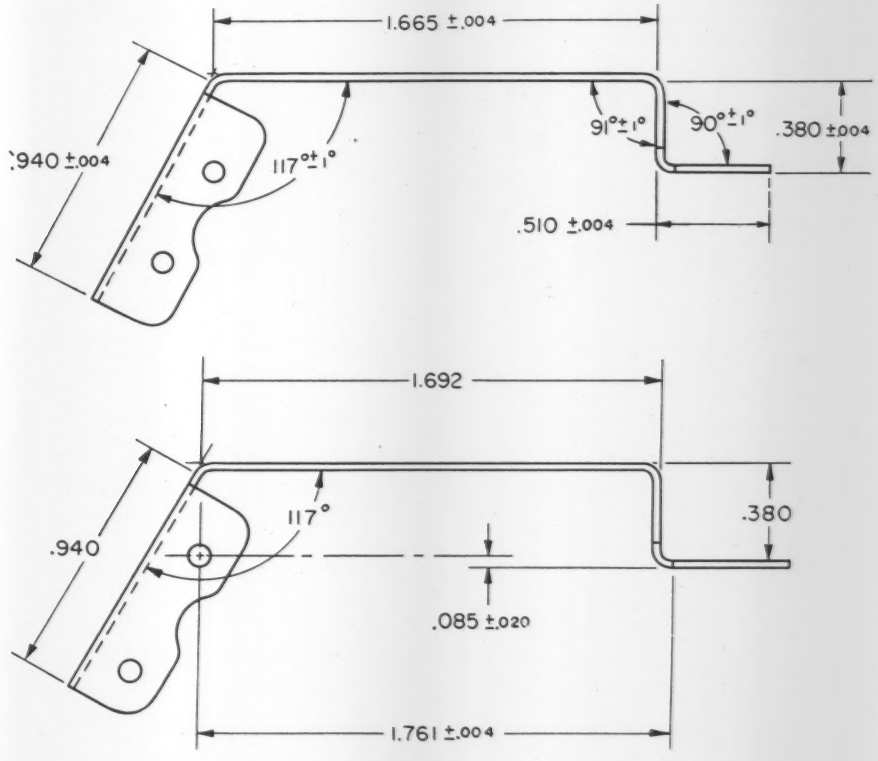


Fig. 8 — Vibrator which was difficult to produce to specification when dimensioned as shown in upper view. Present functional dimensioning, lower view, with appropriate gaging made possible high production of satisfactory vibrators

of the program.

First part of the program was to analyze the various dimensions to be studied and to separate them into their constituent elements. When this was done, studies were made of the variability of each of these elements occurring in production parts. From these data it was possible to draw certain approximate conclusions. However, it was not possible to determine the exact effect variations in stock thickness, hardness, and type would have on the resultant dimensions. To do this, a special die was designed and purchased which had in it all the characteristics where stock hardness, thickness, or materials were felt to be factors. Then stock was specially ordered for use in the die which contained variations in hardness, thickness, and materials across the range that was to be studied at this time. This stock was then run in the die without change of setting and was inspected for the various dimensions and their variability.

Upon the completion of this program, a set of standards was prepared for use by the designers and draftsmen. The standards define exactly how to specify parts to be made in punch presses and what can and cannot be done with present equipment at a standard cost. Sorting operations are, of course, always possible in special cases but they are not desirable as a matter of course. These specifications define the effect of hole size tolerance on die maintenance cost as well as the effect of the stock thickness tolerance on the forming of a right angle or the interchangeability of steel for brass or aluminum.

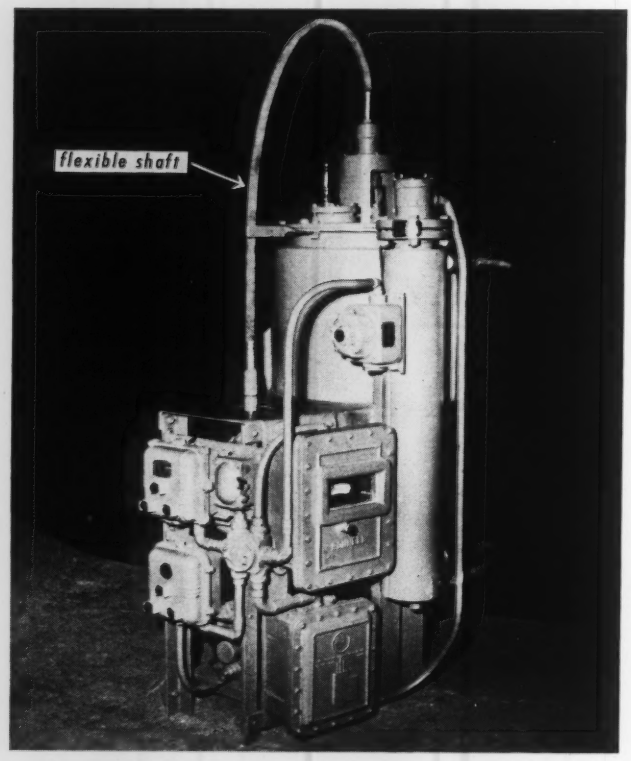
Overall Results: The results of these programs for the establishing of standard tolerances have been:

1. A reduction in debates at planning meetings
2. Better and more efficient designs
3. A reduction in set-up and tool maintenance time
4. Better and more economical quality control of the manufacturing processes
5. Less scrap and rework

These results all add up to a common desirable objective—a better product at lower cost.

Flexible Shaft Solves Design Problem

CONFRONTED with the problem of providing an explosion-proof mixing machine agitator drive, Premier Mill Corp. solved the problem with a flexible shaft. The heavy explosionproof motor could not be located on the mixer cover and coupled directly to the agitator shaft because of safety considerations. Additionally a crane would have been required each time the cover was opened to charge or empty the mixer.

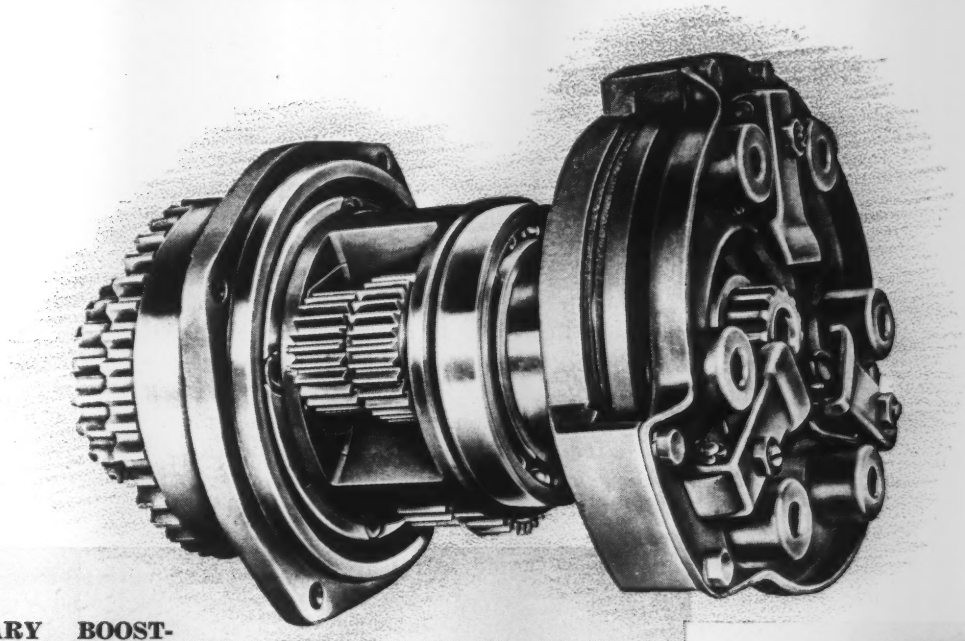


Mounting the 1½-horsepower motor on the side of the machine and connecting it to the agitator shaft with a ½-inch Stow Mfg. Co. flexible shaft answered the question of location. Flexibility of the shaft allows the cover to be opened and closed manually without disconnecting drive components as would probably be necessary with fixed shafting.

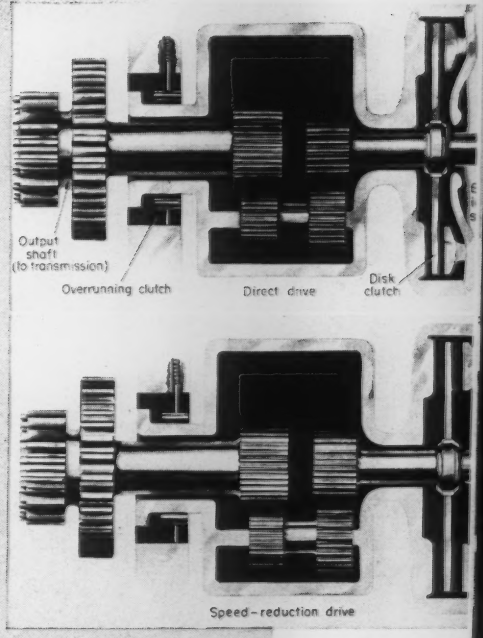
"We have shown what man can make of science. Now it is a question of what our scientific environment will make of man, for an environment affects the form and thought of each new generation. To date, the results of science have been primarily materialistic. We have measured success by our products rather than by ourselves. A materialism which overemphasizes short-term survival detracts from the humanism essential to long-term survival. We must remember that it was not the outer grandeur of the Roman, but the inner simplicity of the Christian that lived on through the ages."—CHARLES A. LINDBERGH.

"Take interest, I implore you, in those sacred dwellings which one designates by the expressive term Laboratories. Demand that they be multiplied, that they be adorned; these are the temples of the future—temples of well being and happiness; there it is that humanity grows greater, stronger, better."—LOUIS PASTEUR.

SCANNING the field for IDEAS



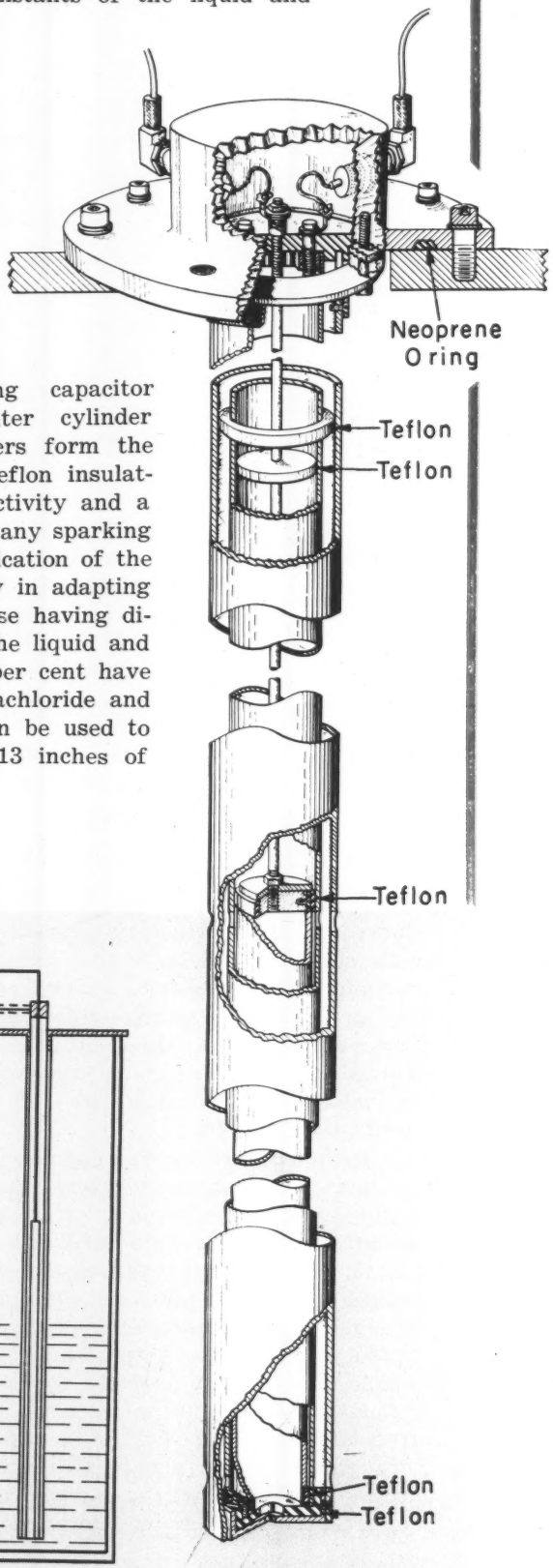
PLANETARY BOOSTER GEARS simplify control and operation of conventional multispeed transmissions. Developed by International Harvester Co., a planetary gear torque-amplifier unit employed with standard five-speed transmissions on the new Farmall and McCormick tractors permits step-down speed changes in any gear without manual clutching or interruption of power flow. In operation, the unit is controlled by a two-position manual lever which can be jockeyed back and forth to provide an instantaneous boost in delivered thrust to meet load requirements.

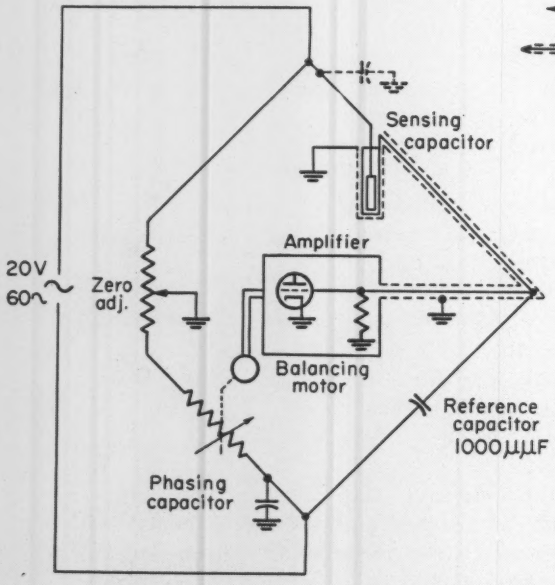


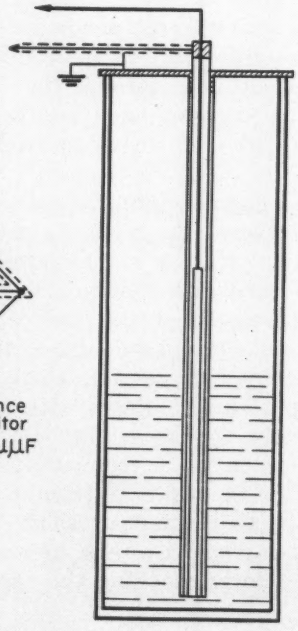
Installed between the engine clutch and the transmission, the unit transmits power from an input to an output shaft through a planetary reduction gear set mounted in a carrier which also has a double-faced disk clutch and an overrunning clutch. Engagement and release of the disk clutch are controlled by the manual lever. For direct drive, the disk clutch is engaged and the planetary gear carrier, along with its associated parts and the output shaft, rotates with the input shaft which is connected directly to the engine. With the clutch disengaged, the unit operates as a conventional countershaft transmission and power is transmitted from the input shaft through the planet pinions to the output shaft, producing a 33 per cent speed reduction. Tendency of the carrier to rotate counter to the input shaft automatically engages the overrunning clutch, locking the carrier hub in a stationary position.

ACCURATE SENSING of liquid levels at extreme low temperatures is accomplished electrically with a system developed by W. E. Williams and E. Maxwell of the National Bureau of Standards in co-operation with the Brown Instrument Div. of Minneapolis-Honeywell Regulator Co. Operation of the system is based on the difference in dielectric constants of the liquid and vapor states of a fluid; the sensing element is a vertical cylindrical capacitor whose capacitance is a linear function of the height of the liquid within it. Capacitance values are measured through a circuit in which the sensing capacitor forms one arm of an ac bridge. Bridge output controls a pneumatic valve which admits more liquid to the system when the level falls below a particular point. Particularly suited for measurement and automatic control of liquefied gases such as hydrogen, nitrogen, oxygen or helium, the device offers high precision and reliability at temperatures approaching absolute zero.

Employing no moving parts, the sensing capacitor consists of three concentric cylinders; the outer cylinder is a grounded shield while the two inner cylinders form the active part of the condenser. Monel tubes and Teflon insulating spacers are used to obtain low thermal conductivity and a Formvar enamel coating on the inner tube prevents any sparking that might occur on accidental tube contact. Modification of the dimensions of the sensing capacitor offers flexibility in adapting the instrument to a variety of fluids including those having dielectric constants which differ as little as 0.05 in the liquid and vapor states. Measurement accuracies to within 1 per cent have been obtained with liquid nitrogen and carbon tetrachloride and the same instrument, with a modified capacitor, can be used to indicate spans of 36 inches of liquid nitrogen or 13 inches of liquid hydrogen.

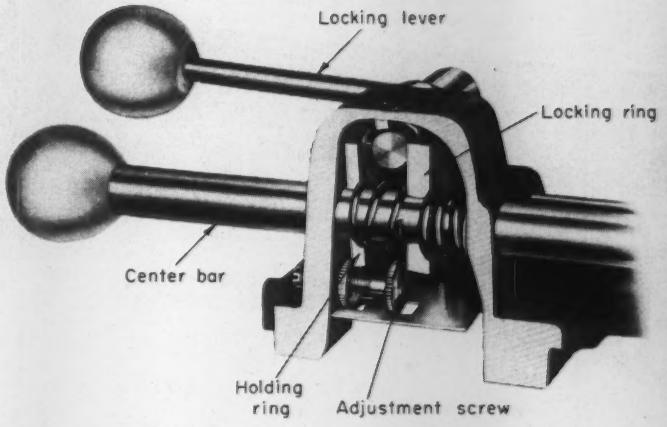




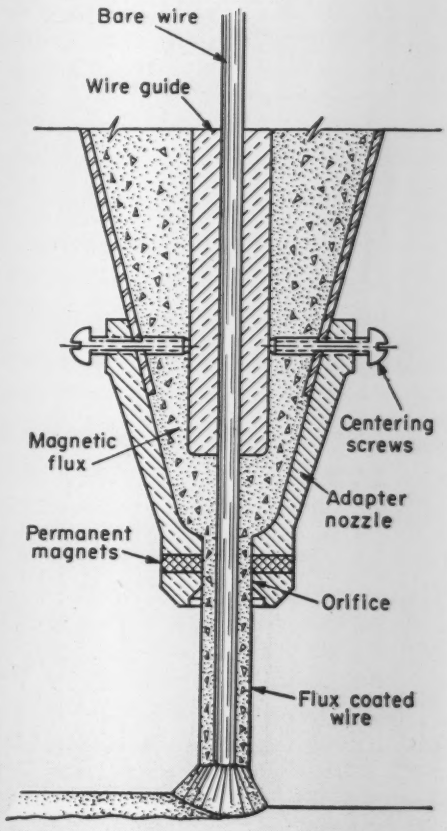


IDEAS

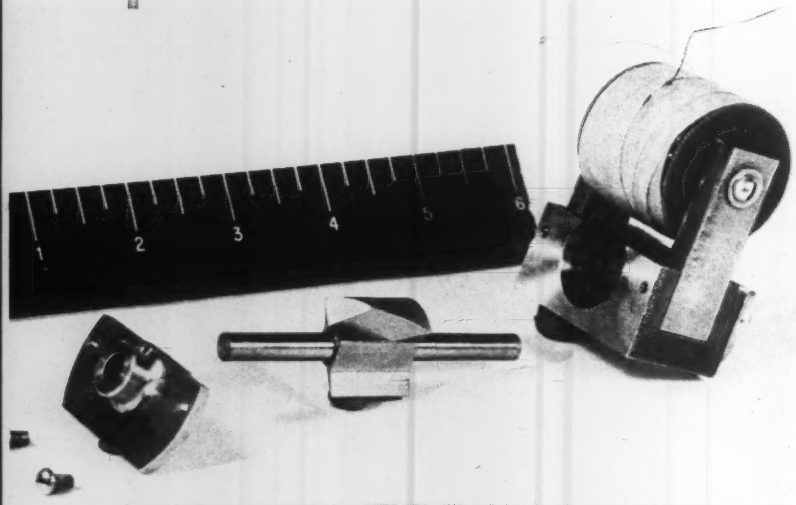
ADJUSTABLE CONTROL of clamping force in Grip-Master vises is obtained with a novel screwless locking mechanism. Holding pressures can be varied from 250 to 1500 pounds by means of a lever which simultaneously advances and locks the vise jaws when "pumped." Developed by Heinrich Tools Inc., the mechanism utilizes the wedging action of two spring-loaded rings to obtain positive locking forces. With the lever vertical, initial holding force is provided by a holding ring which is cocked at an angle under spring action and grips the center bar to resist pressures up to 350 pounds. Depression of the lever actuates the second ring through an offset crank construction, forcibly gripping and advancing the center bar to exert holding pressures up to 1500 pounds. Proper gripping forces are assured by an adjustment screw which permits regulation of the wedging action of both rings. Return of the lever to the upright position releases both rings and unlocks the center bar.

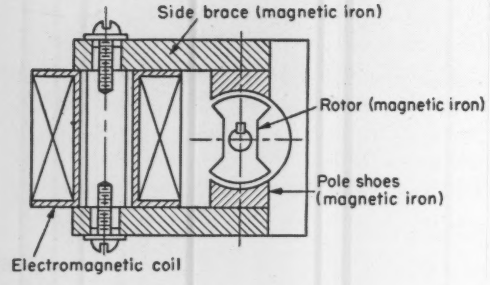


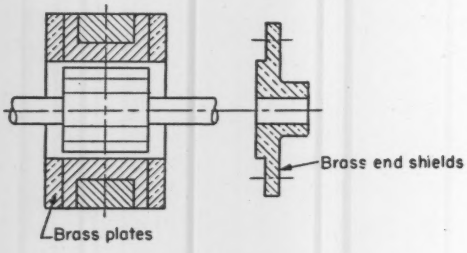
MAGNETIC valve provides accurate control of flow of granular metallic flux in "squirt" welders. In an adapter nozzle design developed by Stoody Co. for use with wire-fed semiautomatic welding equipment, permanent magnets located near the nozzle orifice produce an automatic "valve" action to shut-off the flow of a magnetic alloy flux when the welding process is interrupted. Under normal operating conditions, flux is fed continuously, by gravity, from a standard hopper into the nozzle. As the bare wire passes through the nozzle, the flux adheres to the wire surface under the influence of the magnetic field created by the welding current to provide a continuous, uniformly coated electrode. When the welding current is interrupted, however, the electromagnetic field around the wire collapses and the permanent magnets in the nozzle act to hold back the flow of flux. Conventional flux dams and other auxiliary equipment such as usually required with automatic welding equipment are eliminated by the design which permits even an inexperienced welder to make acceptable manual welds at a rapid rate.



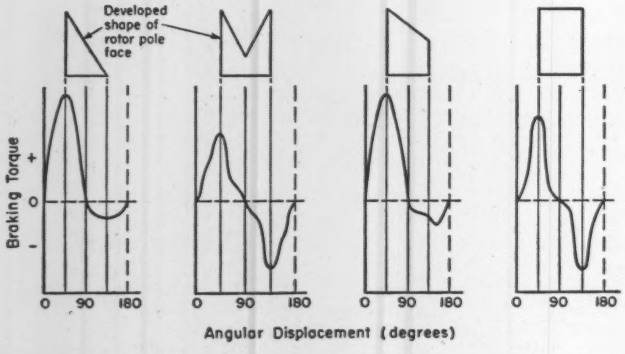
IDEAS







Torque-Displacement Curves for Different Rotor Designs

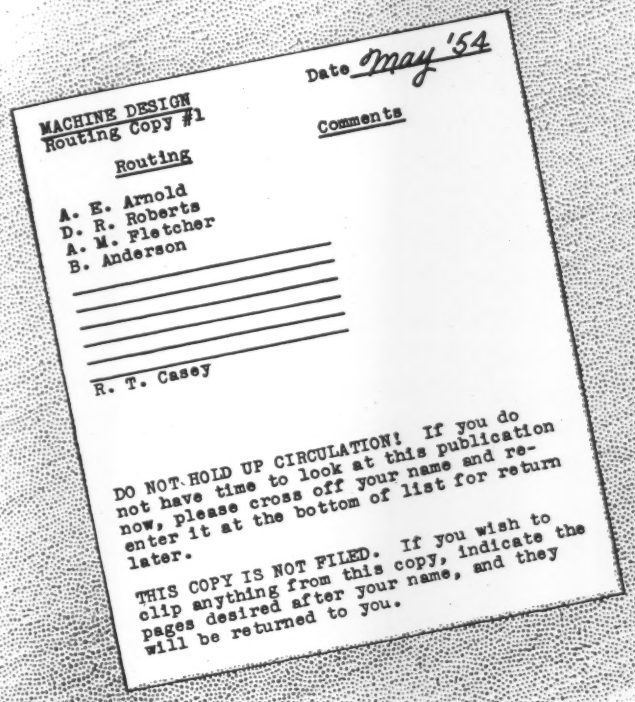


PRECISION INDEXING of light loads at high speeds is accomplished with a novel magnetic ratchet designed by Alfred S. Gutman* for the Air Force Cambridge Research Center. Accurate, rapid stopping action is provided by a two-position magnetic brake geared to the load shaft at a predetermined ratio to produce the desired number of index positions. In the initial design application of the device to a rotating disk assembly, 32 index positions were obtained with a 16 to 1 gear ratio, providing stopping accuracies of within plus or minus 0.5-degree.

Braking torque is produced by a metal rotor which has two pole faces and is designed to stop in one of two positions, 180 degrees apart, when an electromagnetic coil is energized. Modification of the shape of the rotor pole faces provides different operating characteristics and offers flexibility in meeting application requirements with minimum structural innovations. In operation, driving torque is applied continuously, requiring a comparatively low torque driving motor that can be stalled, or a means for disrupting the driving power, when the brake is energized. Power interruption can be accomplished electrically if the driving motor has a low inertia or mechanically by means of a magnetically operated clutch. Small and compact, the device offers possibilities for applications in indicators, computers and other similar types of sensitive or intricate equipment.

*Now of Boston Engineering Lab., Sylvania Electric Products Inc.

Fig. 1 — Design and usage of routing-slip form are important factors in the successful operation of a magazine circulation service



MACHINE DESIGN
Routing Copy #1

Date May '54

Comments

Routing

A. E. Arnold
D. R. Roberts
A. M. Fletcher
B. Anderson

R. T. Casey

DO NOT HOLD UP CIRCULATION! If you do not have time to look at this publication now, please cross off your name and re-enter it at the bottom of list for return later.

THIS COPY IS NOT FILED. If you wish to clip anything from this copy, indicate the pages desired after your name, and they will be returned to you.

KEEPING ENGINEERS POSTED

. . . a system for effective utilization of current technical literature

By Robert T. Casey
Patent Engineer
Trumbull Components Dept.
General Electric Co.
Plainville, Conn.

LARGE quantities of periodical technical literature are available to the design engineer. They cover every aspect of the engineer's job. Their quality is, in general, excellent. The extent and efficiency of the utilization of this valuable material by the engineer, on the other hand, is often deplorably low. An "assist" from engineering management can do much to remedy this, and to increase the benefits that the engineer and his company derive from this important source.

Technical magazines, journals and periodicals provide the most practical way for the engineer to keep himself posted or up-to-date on the three most important aspects of his job. These are: (1) current technical advances, (2) new products, materials and services available for use on his job, and (3) products and activities of other manufacturers.

But before the engineer can come in contact with this useful information, several things are necessary. First, he must know the names of the magazines which are related to his work. Second, he must regularly secure copies of these magazines. And third, if the information is to be truly useful to him, he must have readily available means of access to the vast storehouse of data and information held in the pages of prior issues of such publications.

Several approaches to the problem are possible. Almost any of these approaches, if seriously undertaken and applied with common sense, will produce results. For purposes of illustration this article discusses a service organized, instituted and carried on for a period of several years for the engineers in a medium-sized electrical manufacturing plant.

Before the institution of this service, the individual engineers at the plant were receiving magazine copies in a more or less haphazard fashion. No one could say with any assurance what currently published magazines were most pertinent to the work of the engineers, or which of these magazines, if any, were being received. Often, changes in magazine addressing had not kept up with changes in personnel location, and indexing and filing facilities were completely absent.

The first step taken to remedy this situation was a survey to assemble data. Each engineer was asked to list the magazines he was then receiving or reading regularly. He was also asked if there were any other magazines he knew of that he would like to receive. From information gained from this survey a master list of magazines was compiled. This list was expanded further by adding the names of other magazines gleaned from other sources. The *Ayres Register of Periodicals*, for instance, was consulted. The list was then found to consist of some 45 magazines.

Circulation Service Decided Upon: At this point, and after discussion with other members of engineering management and with the engineers themselves, it was decided that the objective of efficient

utilization of technical publications could best be achieved by the institution of a magazine "circulation service." According to this plan, the magazines would be received by one person, who would circulate them to the engineers interested. This system has been found to have many advantages not obtainable when subscriptions are placed in the names of individual engineers, and magazines received directly by them.

Institution of Circulation Service: Upon review of the master list, common sense indicated that many of the magazines should not be considered further. Magazines which were clearly not pertinent were crossed off the list. A magazine on architecture, for example, was not considered to have enough direct relation to the company's work to justify regularly routing it to engineers' desks. Magazines of the type which report on economic conditions and business statistics were also not considered for general circulation. Two publications were found to cover substantially the same material, and in this case only one was retained for further handling by the service.

This preliminary weeding-out process produced a much smaller "working" list, of about 25 magazines. The next step was to determine the interests of the engineers in these magazines. Accordingly, the list of magazines was circulated, along with the request that each engineer indicate which magazines he would like to receive regularly. A copy of each magazine was made available for his inspection. No limit was set on the number of magazines each engineer could ask for. It was not considered desirable to do this unless absolutely necessary, and to date no restriction has been needed.

The results of this survey were then studied, and a list was compiled of magazines which would be obtained and circulated. In general, it was felt that interest should be shown by at least three engineers in order to justify handling of the magazine by the circulation service. On the other hand, in several cases two or three copies of a single magazine were ordered. It was felt that for proper use by the engineers, no single copy should regularly be routed to more than six engineers. The number of magazines to be handled was then found to be reduced to 15, and on this basis the circulation service began operation.

Routing Slip: While any one of a number of schemes can be used for a routing slip, the form illustrated in *Fig.* 1 has proved satisfactory. This form is used in the following way:

A separate routing slip is made for each magazine. For a monthly magazine 12 copies of the slip are prepared for each copy. For instance, if there are 15 readers who wish to see a particular magazine, three copies are ordered, three routing slips are prepared, with five names on each, and 12 copies of each routing slip are prepared. Each set of 12 slips is then marked with the corresponding month of the year.

Thus, when a magazine is received in the mail each month, the corresponding routing slip is affixed to the cover. Since the routing slips are marked with months in advance, it is always possible to tell whether a given month's issue, or even a given copy, has been received.

The routing slip also provides space at the right of each name for marking pages likely to be of interest. Extra spaces are provided at the bottom for writing in the name of anyone not on the regular list to whom the magazine should also go.

An incidental observation in this connection is that the routing slip should not cover the entire front of the magazine. And unless it is very small, it should not be taped, stapled, or stuck at all four corners. Many magazine covers carry pictures or

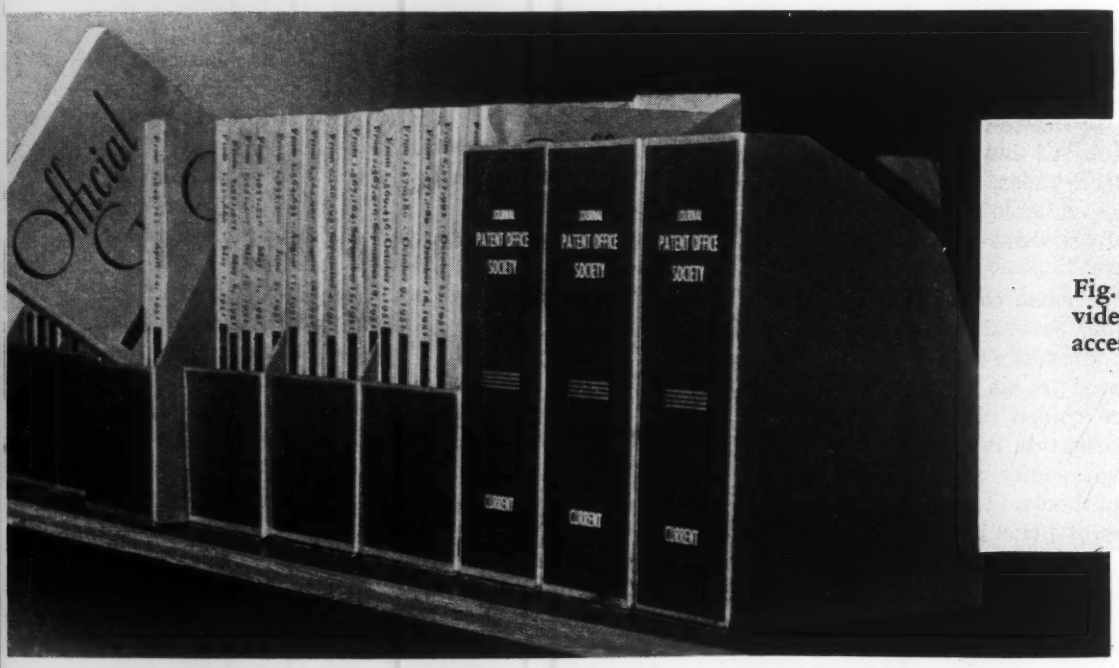


Fig. 2—Open-back boxes provide easy viewing and ready access of smaller magazines in periodical library

titles of important articles, which are meant to be seen and read. By attaching the routing slip at one side or at the top only, it can be lifted up so that the whole cover can be seen.

A constant problem with an undertaking such as this is to keep magazines moving. One help is to keep routing slips as short as possible—not more than six names each. Another aid is provided by a note such as that at the bottom of the slip shown in *Fig.* 1.

Most engineers will be co-operative with this kind of arrangement. For the few who are not, a further precaution is taken. All routing slips are made to terminate with the supervisor of circulation. Since he also keeps back issues of magazines, he will notice when more than one or two months pass before the return of a specific issue. He will then send a note around to "flush out" the copy. All such copies should complete circulation within two months.

Still another feature is provided by the routing slip form shown. For those magazines which are not kept on file after circulation, the note mentioning clippings is added to the routing slip.

Copies which are filed should also be so marked. In connection with the filing of magazines, a convenient filing device for magazines, especially the thinner types, is provided by the open-back cutaway boxes illustrated in *Fig.* 2. The containers protect the copies from becoming dog-eared, and yet permit easy access and viewing of the major portion of the backs of the magazines. In addition, the boxes keep the copies from sagging and from packing together too tightly on the shelf.

The *Official Gazette of the United States Patent Office* requires special attention by the circulation service. No engineering unit can keep itself completely posted on technical progress and other manufacturers' activities without making effective use of it. The *Gazette* contains a drawing and one typical "claim" from every patent issued each week by the United States Patent Office. Its efficient use presents a problem because of its wide scope and great volume of material. Experience has shown that this problem is not best solved by circulating the *Gazette*. It requires at least an hour of skilled and rapid reading to go through one issue of the *Gazette* from cover to cover and pick out the items of special interest. Some of the patents will be sufficiently worthy of attention to warrant obtaining copies of them. This can be done either through the company's patent department, or direct from the Patent Office. The supervisor of circulation will also call certain patents to the attention of the engineer or engineers most likely to be interested in them. He will do this either by showing them the publication notice of the patent in the *Gazette*, or by obtaining a copy of the patent and forwarding it to the party interested.

Back Copies: Efficient use of the magazines requires that at least some back copies be kept on file. Where a full-fledged technical library is not available and where storage facilities are limited, back copies should be kept of at least the most important magazines, and at least one year of back issues should be kept.

A useful index of material in selected technical

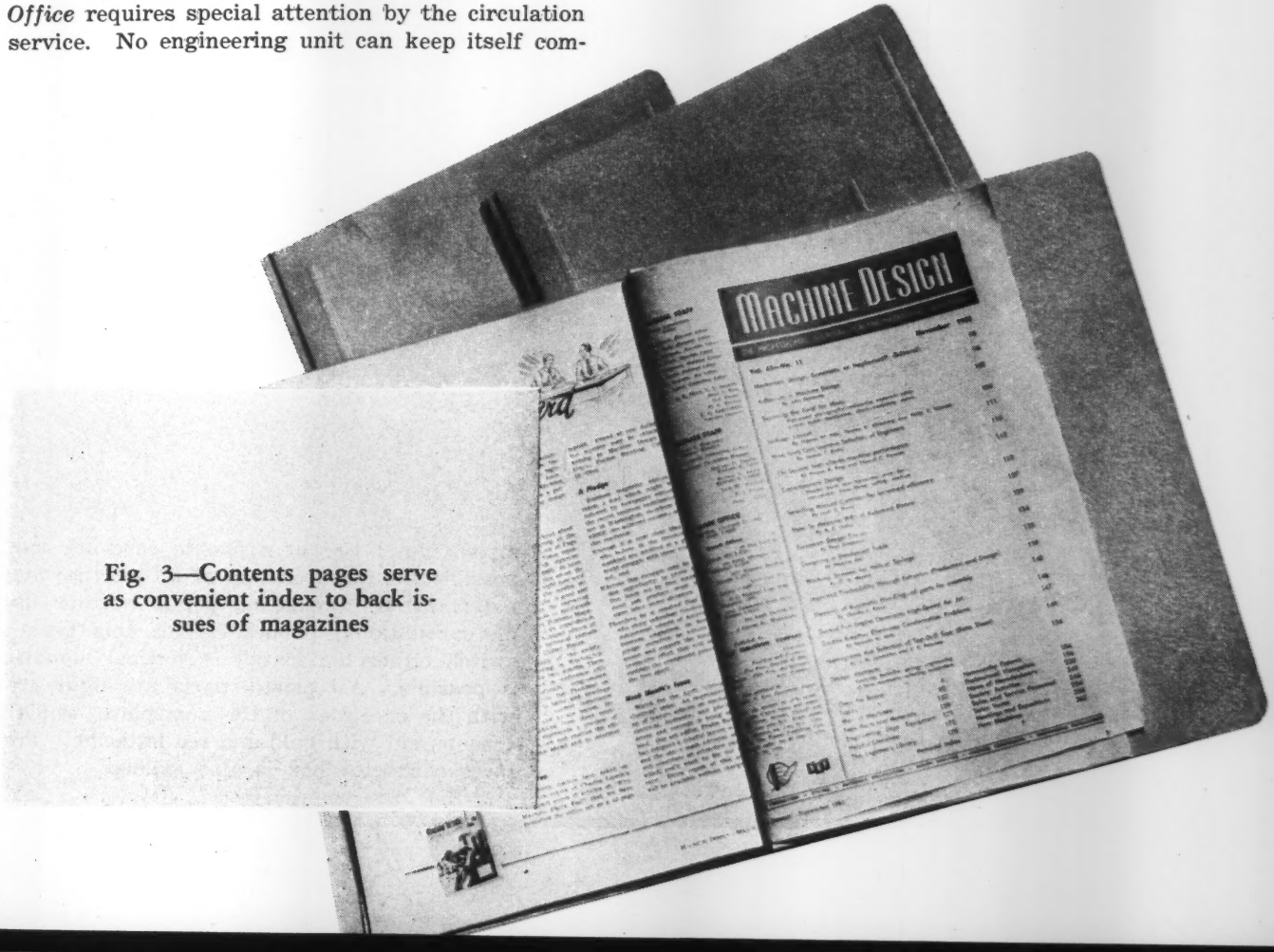


Fig. 3—Contents pages serve as convenient index to back issues of magazines

periodicals can be built up by utilizing magazine contents pages. For instance, when the limit of storage facilities is reached and it becomes necessary to begin discarding copies, the contents pages are removed from the magazines before they are discarded. These are kept in a separate binder, *Fig.* 3, providing a comprehensive index to the material in many back issues. A copy of any technical magazine can almost always be obtained from a public general or technical library once the desired issue is identified.

Technical Papers: The circulation service can supplement its function of supervising magazine circulation by helping to make technical papers, reports and books available to engineers. Technical papers can be routed to the engineer or engineers most likely to be interested in their subject matter. Periodical indexes and listings of technical material from various sources, as well as periodical reports of a more technical nature, are perhaps better handled by the service on a library-check-out basis. If a space cannot be assigned for use as a reading-room or area, a display rack can be provided in a spot where all engineers will see it often.

Where facilities permit, a master data-file or index of all technical material in magazines and technical papers, reports, etc., of interest will also be of very great value. Well worked-out methods of setting up and organizing such files have been set forth.*

Whatever system is now in use, another look at how periodical technical literature is being handled may prove worthwhile. Efficient use of such material requires investment of only a little time and effort combined with common sense. The returns can be immeasurable.

*A. F. Gagne Jr.—"Organizing an Engineering Data File," MACHINE DESIGN, September, 1951, Page 110.

CONTEMPORARY DESIGN

First All-Plastic Telephone

SAID to be the first all-plastic telephone, an interoffice communication unit features five individual private telephone lines in an interoffice system with pushbutton signalling. Handset, telephone base, pushbuttons and the transparent nameplate have been molded in Hercocel A (cellulose acetate) for Connecticut Telephone & Electric Corp., resulting in a compact (4 by 6 inches desk space) and well-

styled unit. Use of a plastic base has made possible the incorporation of an internal magnetic switch, eliminating popup buttons used on conventional phones. With this type of switch either horizontal or vertical mounting is possible. All plastic parts are light gray with the exception of the nameplate, which is transparent with gold and red lettering. Two-piece connector box is also molded.

MOTOR CIRCUIT PROTECTION

Selection of conductors

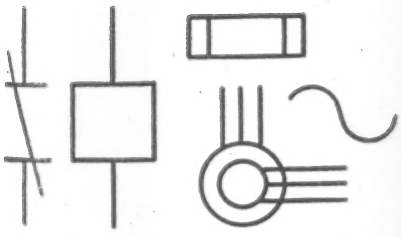
Protection against overloads

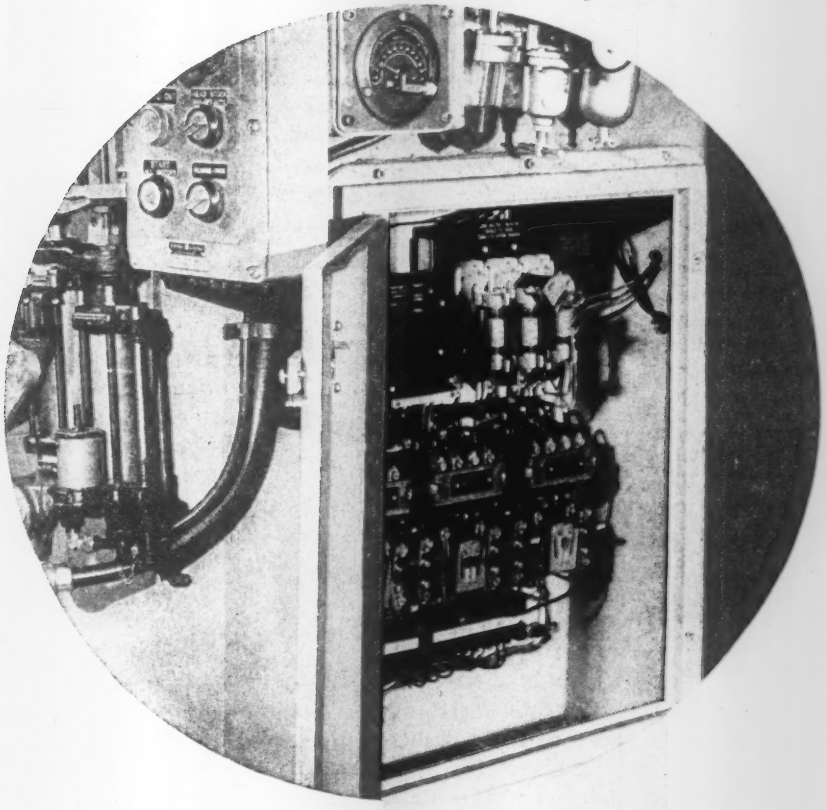
Short-circuit protection

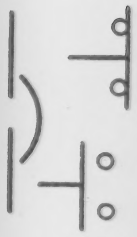
Safety in hazardous atmospheres

By G. W. Heumann

Industry Control Dept.
General Electric Co.
Schenectady, N. Y.







MOTOR CIRCUIT PROTECTION

DESIGNING ELECTRIC MOTOR CIRCUITS FOR OPTIMUM SAFETY

OPTIMUM machine performance is dependent upon the quality of the electrical equipment as well as proper installation. A definite quality level is assured the designer by the electrical industry's adherence to standards established by such organizations as AIEE, ASA, NEMA and the Underwriters' Laboratories. However, the best of equipment may become a hazard if it is improperly selected and installed.

Rules governing selection, co-ordination and installation of electrical equipment so as to render the installation safe against both personnel and fire hazards have been established by the National Fire Protective Association and published as the *National Electrical Code.* The principal causes of fires attributed to motors, controllers and associated wiring are overheating because of excessive current, and ignition of combustible and flammable materials by arcs during normal switching operations. Major methods of prevention covered by this article, and spelled out in the *Code,* are:

1. Selection of branch circuit conductors
2. Protection against overloads
3. Protection against short circuits
4. Construction of motors and controllers for hazardous locations.

SELECTION OF BRANCH-CIRCUIT CONDUCTORS

When current flows through a conductor, heat is generated proportional to its resistance. This heat raises the temperature of the conductor until equilibrium exists between the heat generated within the conductor and the heat carried away by conduction and convection.

Temperature limits have been established by recognized national standards for insulated wire and cable, depending on the composition of the insulation. Any insulating material will age in due course of time, and high temperatures accelerate the process of deterioration. In order to obtain satisfactory insulation life, and avoid a fire hazard because of insulation failure, temperature limits which have been set for various classes of insulating materials should not be exceeded. Based on many tests, and on long operating experience, current carrying ability in amperes has been established for conductors of various sizes, and with various types of insulation, TABLE 1.

When wire sizes for motor wiring are being determined a question arises as to the current rating for which motor-circuit conductors should be selected. Most general-purpose motors are rated on the basis of a 40 C rise. Such motors have a service factor of 115 per cent, which means that they can carry 115 per cent of their rated load without injurious heating, although life of the motor would be somewhat shortened as compared with the life obtained with a 40 C rise limit. No service factor is recognized for conductors; hence their rating must be sufficient to carry any current which the motor may draw in regular operation, over and above the current stamped on its nameplate. To allow for sufficient current carrying capacity, and to have a slight margin of safety with regard to operating overloads, the *Code* stipulates that branch-circuit conductors supplying individual motors shall have a current-carrying capacity of not less than 125 per cent of rated motor current. Conductor sizes for various values of rated motor currents, and for commonly used types of wire insulation are given in TABLE 3. When

GOOD DESIGN PRACTICE requires that machines and electrical equipment be adequately safeguarded against possible accidents. Protection against fire hazards, safety of operating personnel, and prevention of damage to machines is one of the main responsibilities of the designer in selecting proper electrical protective equipment. Conductors of correct size for normal operation, adequate overload and short-circuit current protection devices, and proper enclosures for hazardous locations must be selected and used in motor circuits.

Widely recognized as the definitive standard for selection and installation of such electrical equipment is the *National Electrical Code*. This standard sets forth rules and recommended practices to obtain safe motor circuits. Providing valuable design assistance, primary provisions of the Code are here delineated.

Table 1—Current-Carrying Capacity of Insulated Conductors

Wire Size (AWG or MCM)	Current-Carrying Capacity (amp) (See *Table* 2, below, for letter designations) A, AA	AI, AIA	AVA, AVL	AVB TA, V MI,	RH, RHW	R, RW RU, RUW T, TW
12	40	40	35	30	20	20
8	70	65	60	50	45	40
4	120	115	105	90	85	70
0	225	200	190	155	150	125
0000	340	310	275	235	230	195
500	...	500	470	405	380	320

Table 2—Types of Wire Insulation

Designation—Description

A—Asbestos
AA—Asbestos with asbestos braid outer covering
AI—Impregnated asbestos
AIA—Impregnated asbestos with asbestos braid outer covering
AVA—Impregnated asbestos and varnished cambric with asbestos braid outer covering
AVB—Impregnated asbestos and varnished cambric with outer covering of flame-retardant cotton braid
AVL—Impregnated asbestos and varnished cambric with asbestos braid and lead sheath outer covering
MI—Magnesium oxide with copper outer covering
R—Rubber with moisture-resistant, flame-retardant fibrous outer covering
RH—Heat resistant rubber with moisture-resistant, flame-retardant, fibrous outer covering
RHW—Moisture and heat-resistant rubber with moisture-resistant, flame-retardant, nonmetallic covering
RU—Unmilled, grainless rubber with moisture-resistant, flame-retardant, fibrous outer covering
RUW—Unmilled, grainless rubber with moisture-resistant, flame-retardant, nonmetallic covering
RW—Moisture resistant rubber with moisture-resistant, flame-retardant, fibrous outer covering
T—Flame-retardant thermoplastic compound
TA—Thermoplastic and asbestos with flame-retardant cotton braid outer covering
TW—Flame-retardant, moisture-resistant thermoplastic compound
V—Varnished cambric with nonmetallic covering or lead sheath

Table 3—Minimum Wire Size for Full-Load Motor Currents

(For raceways or conduits)

Full-Load Motor Current (amp)	Wire Size (AWG) R, T*	RH*	Full-Load Motor Current (amp)	Wire Size (AWG) R, T*	RH*
12	14	14	44	6	6
16	12	12	52	4	6
24	10	10	56	4	4
28	8	10	64	3	4
32	8	8	68	2	4
36	6	8			

*See *Table* 2 for letter designations.

motors are used which are not rated on a 40 C rise basis, conductors are selected from TABLE 3 for a current which is 8 per cent higher than the full-load current stamped on the motor nameplate.

In addition to continuously rated motors, motors for special applications are often selected on the basis of special short-time, intermittent or periodic duty rating—for instance crane, hoist, and elevator motors. For such motors, the *Code* permits the use of conductors based on a lower percentage of motor nameplate current.

A similar situation exists in connection with wound rotor induction motors. Secondary wiring to starting resistors carries current only for a short period of time, with long idle times between starts. Hence, conductors selected for full motor secondary current would be considerably underloaded. Smaller conductors, may therefore be used.

PROTECTION AGAINST OVERLOADS

It is assumed that nameplate rating data of motors and controls are in accordance with accepted industrial standards, and that apparatus performing within its rating does not constitute a fire hazard. However, the *Code* has something to say about protecting equipment against use beyond its rating.

An overload on a motor can be defined as an operating condition, not necessarily a short circuit, which causes a current in excess of normal current to flow in the motor power circuit.

Most commonly encountered causes of operating overloads on a motor are:

1. Sustained overload caused by abnormal mechanical load or by low line voltage.
2. Excessive mechanical load which causes the motor to stall or fail to start, thus drawing starting current for a considerable period of time.
3. Single-phasing of polyphase motors, preventing the motor from starting, or causing excessive current to flow while the motor runs.

Overload protection is the protection of the motor, the control apparatus, and the branch-circuit conductors against excessive heating due to motor overload. Overload protective devices, responding to current and/or temperature, interrupt current flow to the motor operating under an overload.

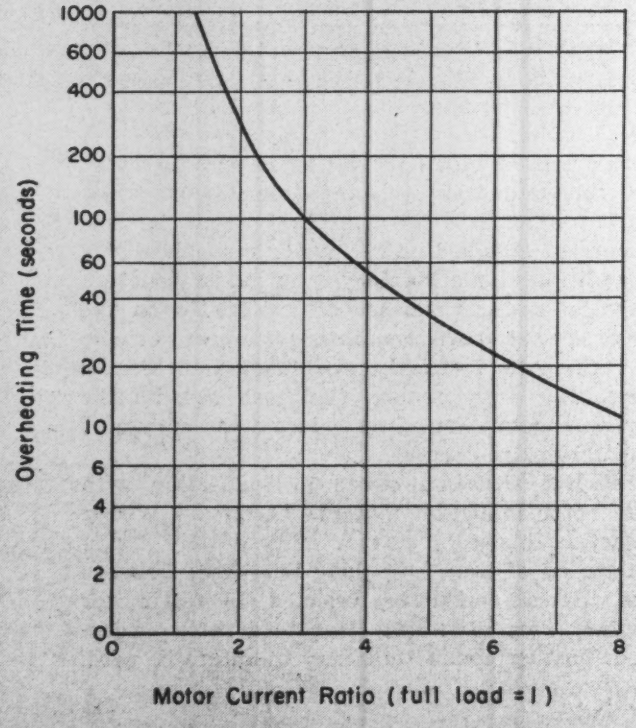
Maximum current to be considered in selecting overload protective devices is the stalled-rotor current which the motor may draw. Ac squirrel-cage motors, representing the largest single category of motors used in industrial, commercial and domestic applications, seldom draw stalled-rotor currents in excess of six times rated full-load current. Thus, 600 per cent rated current establishes the order of magnitude of current which has to be considered in a discussion of overload protection. Overload protection is anchored to motor rating. Hence, it is necessary to analyze what happens to a motor during an overload.

Excessive current causes excessive heating in the motor windings which in turn raises the motor temperature. Even though a sustained moderate overload may not cause immediately apparent damage to the motor, it will accelerate deterioration of the winding insulation and cause eventual failure of the motor. With proper mechanical maintenance, life of a motor is limited by the life of its insulation. Tests on motors of various designs have established that insulation life is approximately halved for each 8 C rise over the maximum safe design temperature. Destruction of the insulation leads to internal faults, resulting in a burned-out motor.

Motor overheating is not only a function of current, but also a function of time. A heating curve of a typical industrial ac motor, *Fig.* 1, indicates the time within which the motor attains a dangerous overtemperature when carrying various amounts of current. This curve has an inverse-time shape, and overload protective devices should function to disconnect the motor before a dangerous overtemperature has been reached.

Motors have considerable overload capacity for short periods of time. Good overload protective devices should allow the motor to use this overload capacity. In other words, the tripping characteristic of a protective device should match, as closely as practicable, the heating curve of the motor.

Fig. 1—Typical heating curve for a general-purpose industrial electric motor shows time required for the motor to reach dangerous overtemperature at various current values



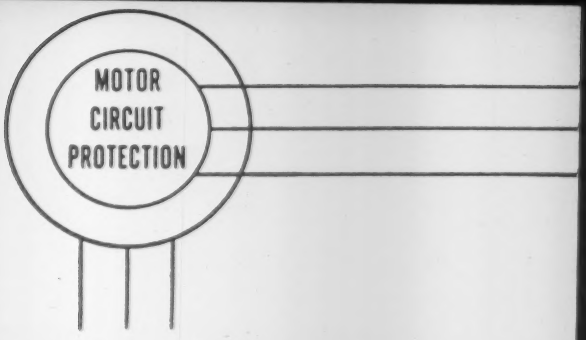
Fuses: Fuses are among the oldest types of overcurrent protectors. Single-element fuses of the renewable or nonrenewable type ultimately blow at about 115 to 125 per cent of their rated current. When applied for motor protection, the *Code* permits selection of fuses having a current rating of 125 per cent of rated current for 40 C rise motors, and 115 per cent of rated current for all other motors. Fuses are primarily used for protecting conductors, and they have been used widely for protecting small motors, generally in the fractional sizes. Fuses are not generally used to protect larger motors in industrial plants, since their melting characteristics do not match motor heating characteristics too well. If the fuse is selected to protect the motor on slight overloads, it does not permit the motor to utilize its full overload capacity, and it melts too quickly on heavy overloads. If the fuse is selected to protect a motor against

a heavy overload, it may not melt on slight overloads and thereby will permit the motor to overheat.

A recent development is the dual-element fuse which contains a conventional element to melt at high current, and a special element having an inverse-time characteristic to approximate the motor-heating curve. Since this type of fuse has not yet been used as universally as some other types of protective devices, it is too early to fully evaluate its merits, and further experience will have to be gained before a full evaluation can be made.

Inherent Overheating Protectors: Assembled inside the motor, these thermal devices are exposed to the heat generated within the motor. Some designs also respond to current in the motor lead. When the tripping characteristics of these devices are closely matched with the motor heating curve, they provide excellent motor protection. Because the transfer of heat to the protector depends on the geometry of the motor, protector design must be matched with a specific motor, and protectors are not marketed as supply items for general use. Inherent protectors are generally used on small fractional horsepower single-phase motors produced in large quantities. Co-ordination between individual motors and protectors for special applications would entail an uneconomical application engineering effort. Motors and their inherent protectors have to be tested together and approved, which is generally done by the Underwriters' Laboratories Inc. or some other agency recognized by the *Code*-enforcing authority.

Inverse-Time Circuit Breakers: Some circuit breakers with nonadjustable inverse-time or thermal-magnetic trips are used as motor starters with motor-overload protection, and the *Code* sanctions such use. It is quite possible to match circuit breaker tripping and motor heating characteristic to obtain satisfactory protection. However, since circuit breakers are devices which are not designed for frequent operation, the use of circuit breakers as motor starters is restricted to drives which are started infrequently.



Thermal Overload Relays: The most widely used overload protective devices—thermal overload relays—are built by practically all manufacturers of industrial control equipment. Universally used for the protection of industrial type, continuously rated motors, these relays are "replica types," that is, they reflect on a reduced scale the heating effect due to motor load current. A typical tripping characteristic, *Fig.* 2, illustrates the inverse-time relay tripping characteristic. Since the relay responds to heat, it has to cool before it can be reset. This is indicated by the resetting curve.

Thermal overload relays utilize the heat-storing ability of a thermal responsive element and connected mass. The heat generated by the motor load current flowing through the relay is conducted, convected or radiated to this element. This heat transfer causes the relay contact to open and trip out the motor starter when the thermal element has reached a certain temperature. The current at which the relay ultimately trips at an ambient temperature of 40 C is the rated current of the relay. A comparison of time-current characteristics for relay tripping and motor overheating, *Fig.* 3, shows the relay will trip before the motor has reached its maximum permissible temperature, and full protection is afforded to the motor. Two types of thermal overload relays are in widespread use today, namely bimetal and solder-film relays.

With rising temperature, the bimetal of a bimetal relay, *Fig.* 4, deflects. When a temperature in the vicinity of 100 C is reached, the bimetal has deflected sufficiently to trip the contact mechanism which opens the relay contact. After the relay has cooled and the bimetal has returned to its original position, the relay may be reset by pressing its reset knob. By a simple adjustment, the

Electric drives used almost universally on machines require proper installation and protective devices to safeguard both motors and machine operators. Controllers used with these machines include motor starters, overload protective devices and short circuit protective devices

Photo, courtesy Electric Storage Battery Co.

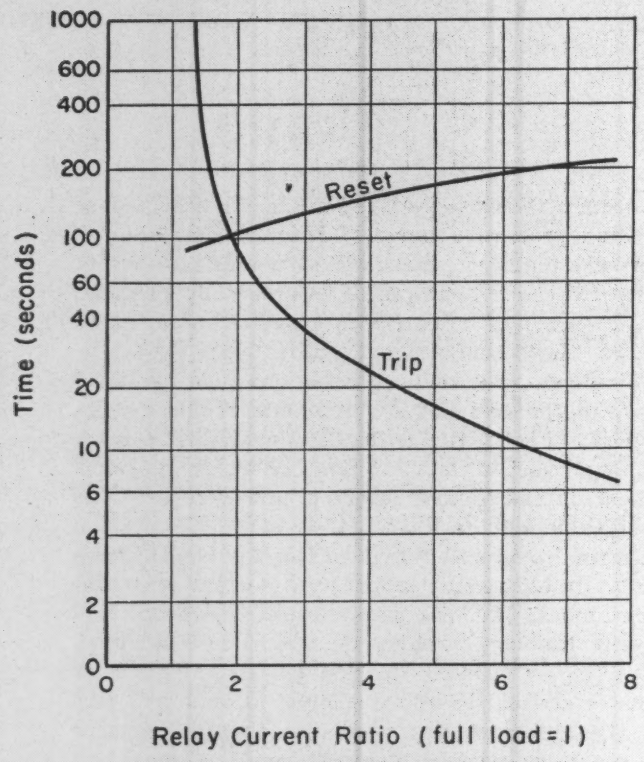
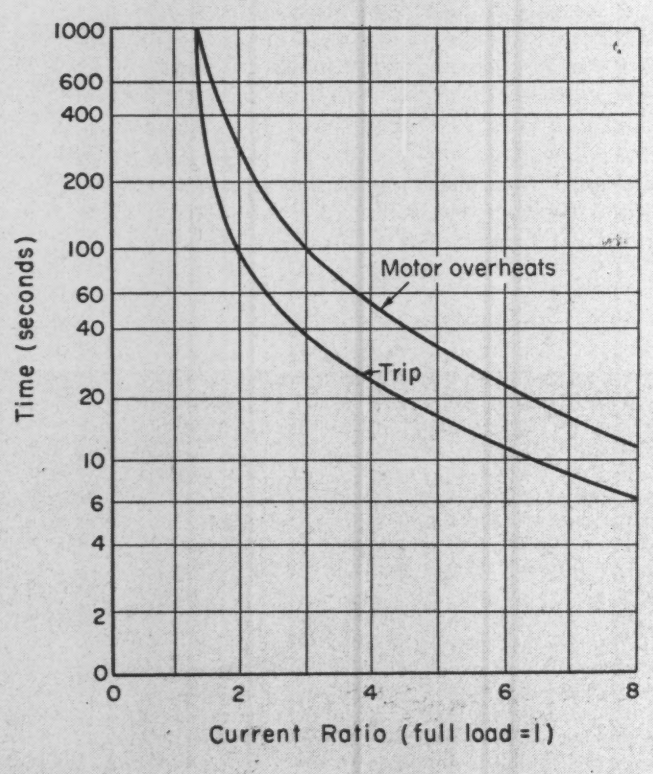


Fig. 2—Above—Tripping characteristic of a thermal overload relay is similar to motor heating curve. Reset characteristic indicates cooling necessary before relay can be reset

Fig. 3—Below—Superimposed motor heating and relay trip characteristics demonstrate that relay contacts open before dangerous overtemperature is reached



relay can be made to reset automatically.

Solder film relays, *Fig.* 5, utilize a eutectic alloy with a low melting point, which changes abruptly from solid to liquid state at a critical temperature. When sufficient heat has been generated by the relay heater, the solder film softens suddenly, releases the spindle and a spring mechanism, which trips the relay contact open. After the relay has cooled sufficiently to permit the solder film to harden it may be reset manually. Solder-film relays cannot be obtained for automatic resetting.

It is uneconomical to design and build distinctive relays of either type for each possible value of motor current. Instead, relays are built in quantity as identical units, and co-ordination between relays and motors is accomplished by designing for each relay a line of interchangeable heaters.

NUMBER OF OVERLOAD RELAYS: To provide protection under any condition of overload, the *Code* prescribes the number of overload relays to be used, *Fig.* 6. Overload relays are connected in ungrounded lines. For single-phase and dc motors, one relay is used. For two-phase motors, two relays are used, one in each phase. For three-phase motors, two relays are used, one in each of two phases. With this arrangement, at least one relay will "see" the overcurrent, either because of a true overload, or because of single-phasing. The standard of the control industry is to equip single-phase starters with one overload relay, and polyphase starters with two overload relays. There are a few special cases, especially when wye-delta or delta-wye connected transformers feed a distribution system, where three overload relays have to be used for full protection of three-phase motors.

SELECTION OF RELAY HEATERS: For economy in design, most thermal overload relays are nonadjustable. Since it is impracticable to design relay heaters for an infinite number of possible motor currents, because of limitations imposed by finite steps in heater wire, a complete line of relay heaters is laid out in definite steps, and each heater serves a range of motor currents. Rated current of the heater is that current on which it will cause tripping ultimately in 40 C ambient.

Rated current of overload relays should not exceed 125 per cent of the full-load current of motors rated on a 40 C temperature rise, or 115 per cent of all other motors, according to the *Code*. If this requirement cannot be met by a line of standard heaters, the next larger size heater may be used, provided the rated heater current does not exceed 140 per cent of the full-load current of 40 C rise rated motors, or 130 per cent of the full-load current of all other motors.

Standard lines of relay heaters are generally laid out in steps of approximately 10 per cent between heater currents to allow full utilization of the motor's service factor and overload capacity. To simplify heater selection, manufacturers generally publish heater tables for 40 C rise general-purpose motors, indicating the range of motor currents for which each heater is recommended. Sometimes it is necessary to select heaters for 50 C rise

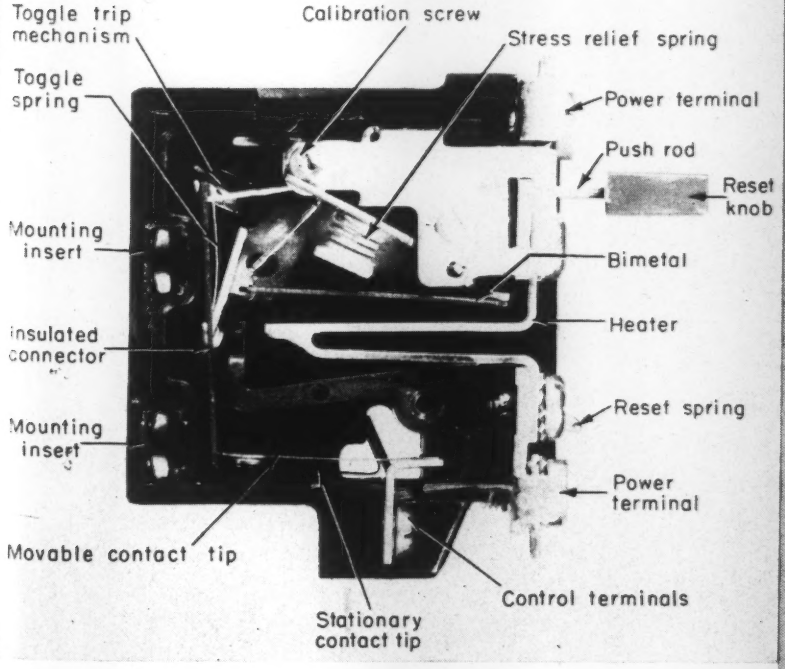
on intermittent-rated motors. If the relay manufacturer has not published any recommendations for those special-purpose motors, relay heaters may be selected from a standard relay table by using conversion factors in TABLE 4.

Selection of Motor Controllers: Since the *Code* does not govern quality of product, it simply states that motor controllers shall be rated in amperes and horsepower, and they shall be capable of interrupting locked-rotor current. Manufacturers list their standard starters with horsepower ratings, and it is understood that they are capable of interrupting six times their rated motor current repeatedly, in accordance with the standards of the Underwriters' Laboratories Inc. In order to specify the current values at which controllers should be tested to verify their ratings, the *Code* publishes tables giving average full-load currents of ac and dc motors of standard ratings. As an example, TABLE 5 lists average full-load currents of three-phase induction motors.

A somewhat unusual condition exists when hermetic motors are used on refrigerating, air conditioning, and similar equipment. A hermetic motor operates in a refrigerated atmosphere, that is at an ambient temperature considerably below the normal 40 C on which most apparatus ratings are based. Such motors are permitted to carry higher currents than normal motors of comparable size, without exceeding the maximum design temperature of the motor insulation. However, the locked-rotor current of a hermetic motor is the same as for a normal motor of comparable size.

Giving such a motor a horsepower rating would be confusing, because the difference between normal full-load and locked-rotor current is smaller than for normal motors, and standard controllers, based on normal horsepower ratings, would be poorly utilized with respect to interrupting ability. To permit better utilization of controllers, the 1953 edition of the *Code* contains new provisions for hermetic motors. Compressors with hermetic motors must be rated in full-load and locked-rotor current. Controllers, which have an established current-carrying and interrupting rating, may be applied on that basis. Special starters are on the market which have been designed especially for the air conditioning industry, and which are marked with a running current and locked-rotor current rating. To permit co-ordination between hermetic motors and standard starters, the *Code* includes information which allows selection of standard controllers on the basis of compressor locked-rotor current.

Fig. 4—Contacts, bimetal, heater and actuating mechanism of this typical bimetal overload relay are enclosed in a molded housing



SHORT-CIRCUIT PROTECTION

Short circuits may occur in any power system. There are no economical means for preventing them entirely. In motor branch-circuits, short-circuits usually occur in the conduits between the motor and the controller. Since occasional faults are unavoidable, the *Code* requires that every mo-

Table 4—Thermal Overload Relay Heater Conversion Factors

Motor Rating Basis	Motor Capacity, Continuous (% of rating)	Factor
40 C rise, continuous	115	1.00
50-55 C rise, continuous	100	0.90
50-55 C rise, 1 hour	80	0.80
50-55 C rise, 30 minutes	70	0.75
50-55 C rise, 15 minutes	55-60	0.70

Table 5—Full-Load Currents for Three-Phase Induction Motors (average)

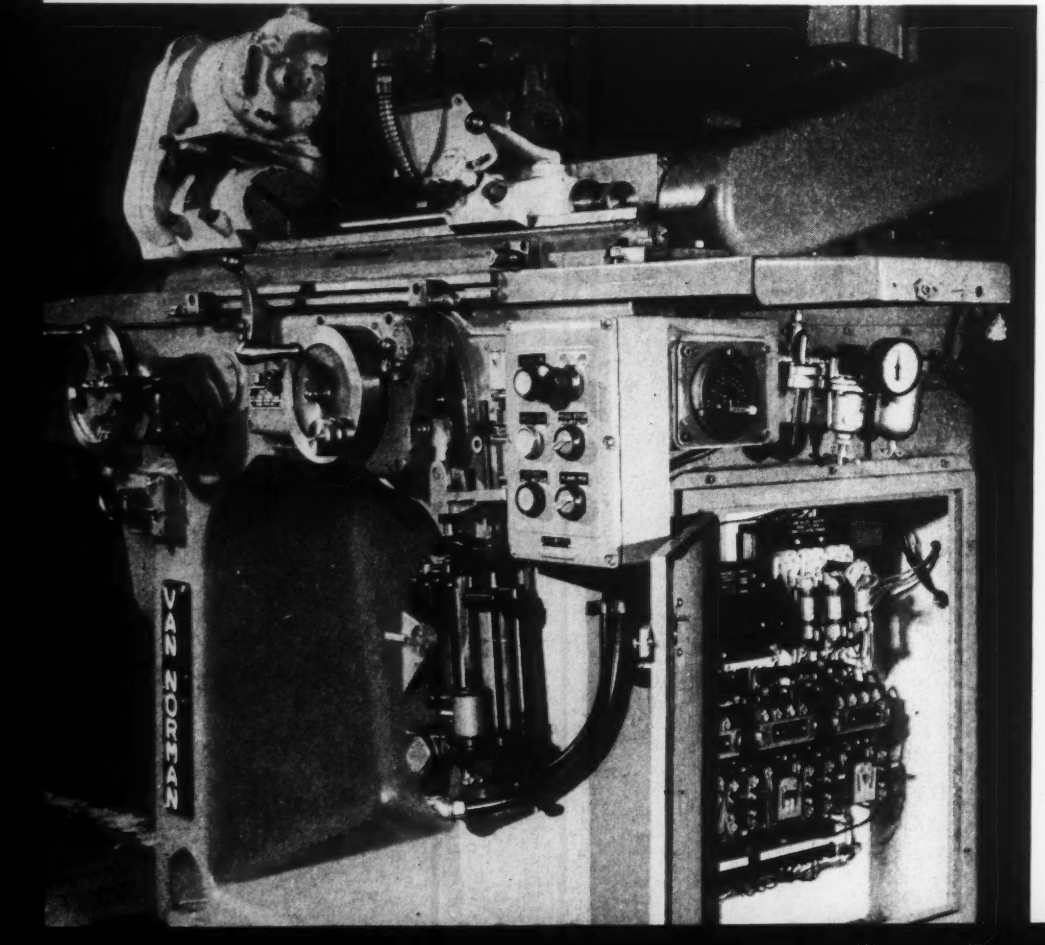
Motor Rating (hp)	Full Load Current (amps) at 110 v	220 v	440 v	550 v
1	7	3.5	1.8	1.4
3	..	9	4.5	4
5	..	15	7.5	6
10	..	27	14	11
15	..	40	20	16
25	..	64	32	26
40	..	104	52	41
50	..	125	63	50
75	..	185	93	74
100	..	246	123	98

tor branch-circuit be protected against the devastating effects of short circuits. Motor starters are not capable of interrupting the high currents which may flow under fault conditions, because they are designed to interrupt motor locked-rotor current. Other devices must be utilized to provide short-circuit protection.

Short-circuit currents in a branch-circuit do not depend on motor rating but on the characteristics of the power system to which the motor is connected. A simplified diagram of a power system from the generating station to the plant where the motor and its controller are installed, *Fig.* 7, shows that the worst location of a fault would be at the load terminals of the starter. Magnitude of the short-circuit current which may flow depends on the total impedance of the circuit from the source of power to the point of fault. This total impedance includes the impedance of the motor starter and the impedance of the fault. This portion of the total impedance is difficult to evaluate and varies from case to case. It is affected by the size of the starter, and particularly the resistance of the overload relay heaters. To select short-circuit protective means on a uniform basis, it is customary to calculate an "available short-circuit current" which would flow if the line terminals of the controller were short-circuited. The maximum short-circuit current which would actually flow in the branch-circuit would be somewhat smaller than the calculated short-circuit current.

Most industrial power users are connected to a fairly large and interconnected power system. On such a system the impedance between the power source and the high-voltage side of the transformer feeding the branch-circuit is small, and the voltage drop to the transformer may be neglected. It is reasonable to assume that the system voltage on the high side of the transformer remains at its normal level during a fault. The magnitude of the short-circuit current is thus determined by the impedance of the step-down transformer and the motor feeder. If a starter is installed close to a transformer bank, a total fault impedance of 5 per cent is not uncommon. This means that, if no other motors were running which would contribute current to the fault, the short-circuit current would be 20 times the rated current of the transformer. Available short-circuit currents for various ratings of transformer banks are tabulated in TABLE 6. Because of the contribution to the fault current by induction and synchronous motors which may be running when the fault occurs, the available short-circuit current may actually be approximately 10 per cent higher than the current as calculated by the above given method.

Short-circuit current thus calculated is a symmetrical rms current, or the steady-state current which would ultimately flow at the point of starter installation, *Fig.* 8*a*. It is the current which the power company might give to the user as the available short-circuit current at the power company's terminals in the plant. Symmetrical short-circuit current flows if the fault occurs when the feeder

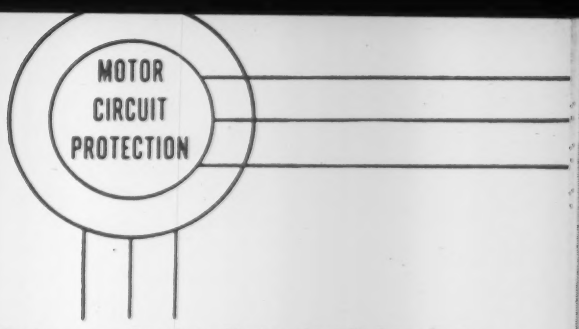


Control panel mounted in base of cylindrical grinder has magnetic starters with overload protective relays. Fused motor circuit switch protects against short circuit currents

Photo, courtesy Van Norman Co.

voltage wave is near its peak. If the fault occurs at any other instant the short-circuit current includes a transient dc component which is maximum if the fault occurs when the feeder voltage is near zero, *Fig. 8b*. The dc component decays to zero within a few cycles. However, the design of apparatus suitable for interrupting short circuits must take into account the mechanical and thermal stresses caused by the initial offset current.

Circuit Breakers and Fuses: To provide protection of the power system against short circuits, to protect the branch-circuit conductors, and to protect the starter itself against destruction, the starter must be backed up by devices which are capable of interrupting short-circuit current with safety. Two kinds of devices are recognized by the *National Electrical Code,* namely time-limit circuit breakers and fuses.



Under existing industrial standards it is customary to rate low-voltage power-interrupting devices in terms of total interrupted rms current. To establish a uniform basis for interrupting ratings, it is assumed that the dc component of the short-circuit current adds 25 per cent to the calculated rms symmetrical current. As an example, if cal-

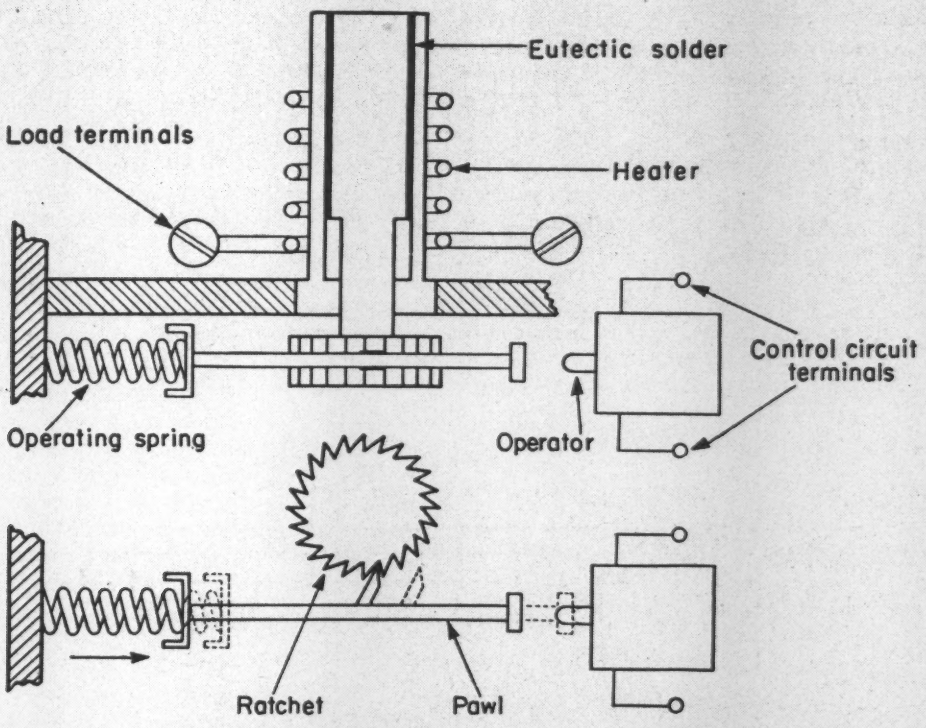
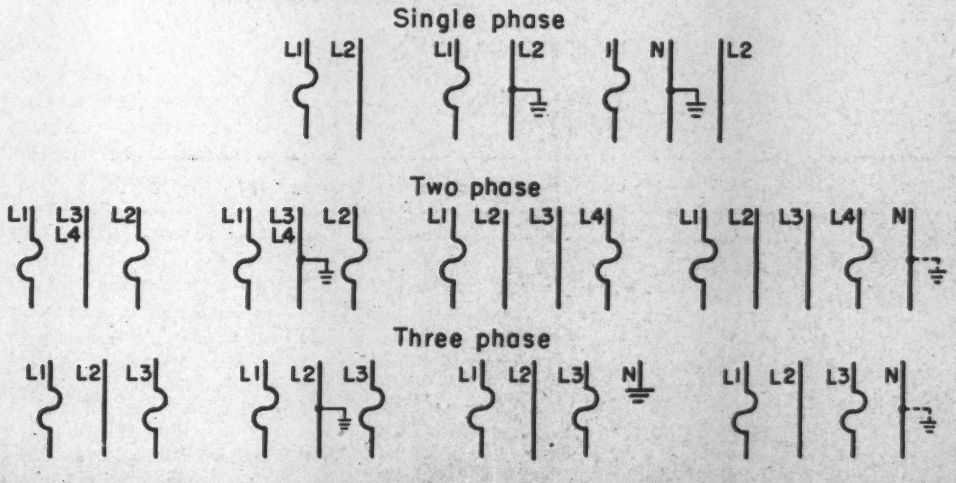


Fig. 5—Eutectic alloy changes abruptly from solid to liquid state at a critical temperature, releasing spindle to open contacts of solder-film overload relay

Fig. 6—Location of overload relays in motor branch circuit



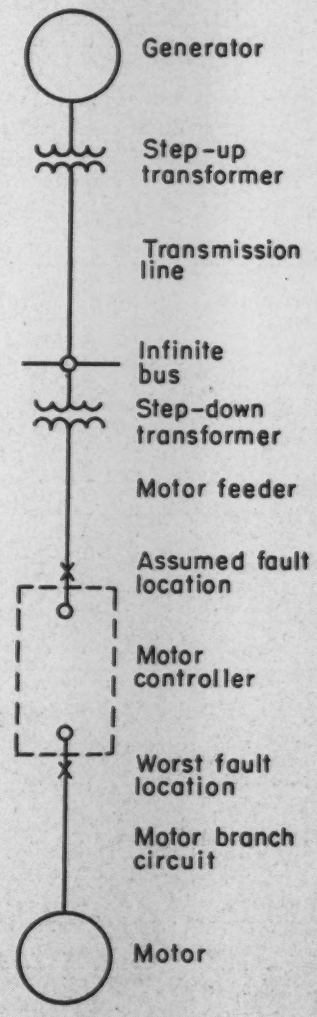


Fig. 7 — Simplified diagram of faulted motor branch circuit

Table 6—Short-Circuit Currents

(Total fault impedance, 5 per cent)

Transformer Bank Rating (kva)	Current at 480 v (amp)	Current at 240 v (amp)
10	240	480
15	360	720
25	600	1 200
50	1 200	2 400
75	1 800	3 600
100	2 400	4 800
150	3 600	7 200
200	4 800	9 600
250	6 000	12 000
333	8 000	16 000
500	12 000	24 000
1000	24 000	48 000
1500	36 000	72 000
2500	60 000	120 000

culation obtains a symmetrical available short-circuit current of 12,000 amperes, a circuit breaker should be used having an interrupting rating of 15,000 amperes.

Concerning the number of overcurrent trip elements or fuses, the *Code* requires that protection be provided in each ungrounded conductor, *Fig.* 9. Hence, triple-pole starters on three-phase or two-phase three-wire systems must be protected by circuit breakers with three overcurrent trips, or by three fuses.

The *Code* also stipulates that disconnecting means be provided in each ungrounded conductor. Circuit breakers inherently act as disconnecting means. When fuses are used for short-circuit protection, a switch is used. Switches should have sufficient interrupting ability to interrupt locked-rotor current. Up to 50 horsepower, motor-circuit

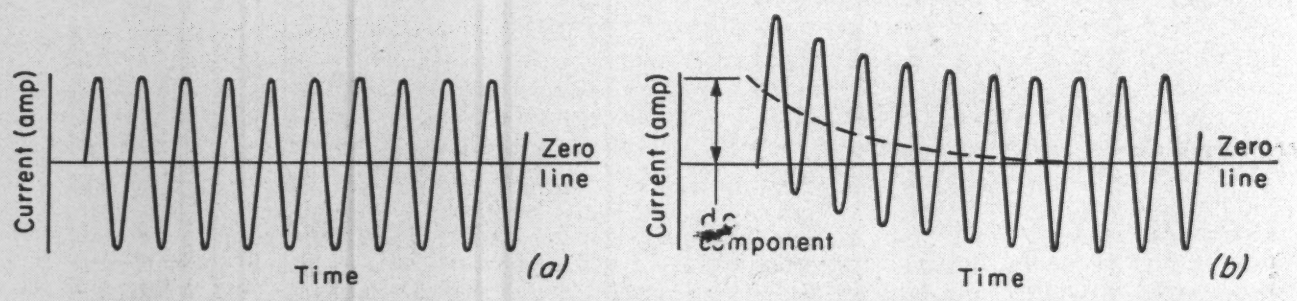
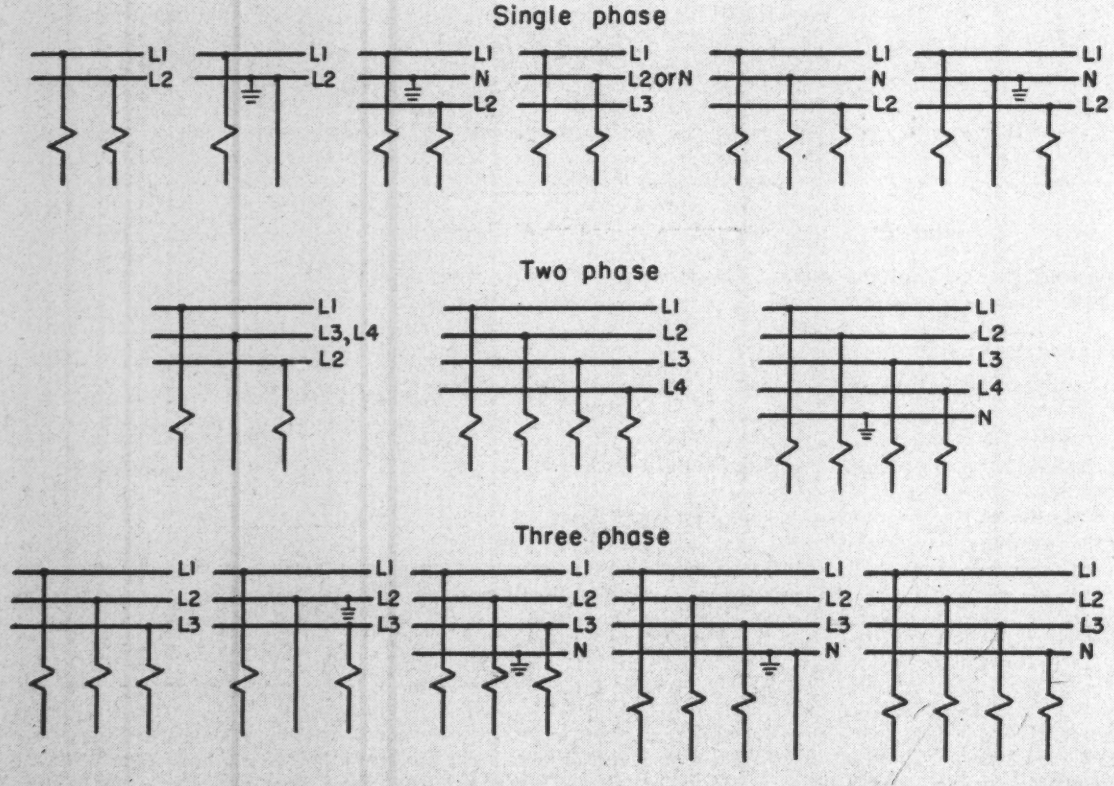


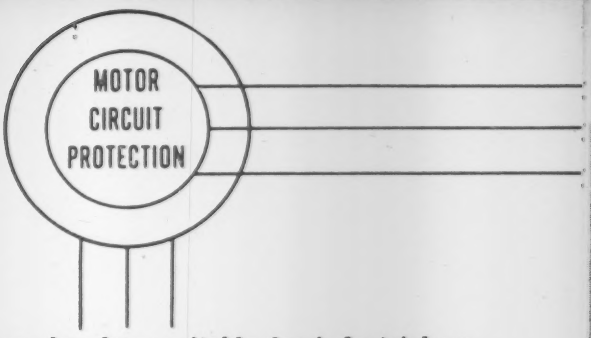
Fig. 8—Symmetrical short-circuit current, *a*, flows if fault occurs when voltage is near its peak. Fault occurring when current is not near peak produces asymmetrical short circuit current, *b*

Fig. 9—Location of short-circuit protective devices in motor branch circuits



switches are available which are rated in horsepower and can interrupt stalled-rotor current. Above 50 horsepower, general-use switches should be used which are rated in amperes, and which should be so selected as to allow for locked-rotor current interruption. Isolating switches, capable of carrying but not interrupting current, may be used if they are plainly marked by a sign "Do not open under load."

Popular types of breakers used on low-voltage circuits of medium interrupting capacity are the so-called molded-case air circuit breakers. They derive their name from the fact that they are completely housed in a molded compound case. Manually operated, they have combination thermal and instantaneous nonadjustable trips. At low overcurrents, up to approximately 10 times rated breaker current, the thermal trip is effective, and the breaker has an inverse-time characteristic. Above approximately 10 times current, the instantaneous trips take over and open the breaker within one to three cycles, depending on breaker size, *Fig.* 10.

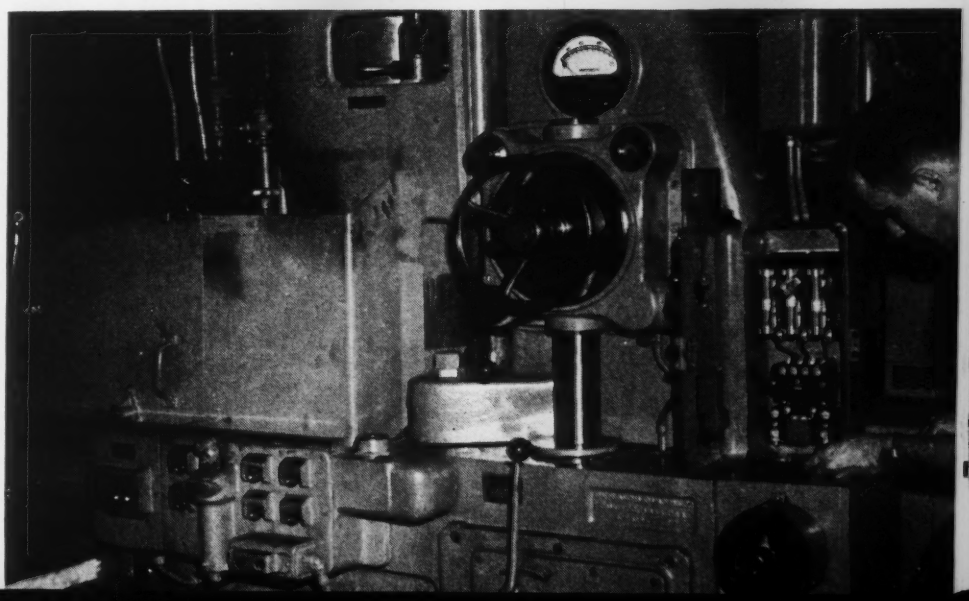


Molded-case breakers suitable for industrial applications on circuits up to 600 volts are available in three frame sizes. Breakers with 100- and 225-ampere frame size have an interrupting ability of 15,000 amperes, and 600-ampere frame breakers have an interrupting ability of 25,000 amperes. In each frame size a number of trip ratings are available, the smallest one being 15 amperes.

Fuses may be conventional NEC fuses which are available in a large number of current ratings for 250 and 600-volt circuits. Fuses are tested by Underwriters' Laboratories on a 10,000-ampere dc test circuit, but they do not have a stated interrupting rating on ac circuits. Operating experience indicates, however, that conventional NEC cart-

Compressor unit consisting of a modified automotive engine driven by an electric motor has a base mounted starter incorporating thermal overload relays. Starter contactor can interrupt stalled rotor current of the motor

Photo, courtesy Gordon Smith Co.



Fused motor circuit switch, which is a part of the combination starter on this grinding machine, protects against short circuits. Thermal overload relays prevent damage to the motor from large or small overloads

ridge fuses are satisfactory as short-circuit protective means in locations where the available short-circuit current does not exceed 25,000 amperes.

All fuses are current-limiting to a certain extent, *Fig.* 11. If a high short-circuit current, either symmetrical or asymmetrical, begins to flow, the fuse melts during the first half-cycle, before the current reaches its peak value. Thus, maximum short-circuit current does not flow through the connected apparatus, and stresses due to let-through current are relatively low.

Recently, several fuse manufacturers have announced high interrupting-capacity fuses which have been designed specifically for current-limiting action, and which have a stated interrupting rating. In outward appearance and dimensions they do not differ from conventional NEC fuses, and they fit standard fuse clips. Hence, conventional fuses may be replaced by high interrupting-capacity fuses. On the other hand, special reject-type fuse clips are available which make it impossible to replace high interrupting-capacity fuses by ordinary fuses, if the owner of the equipment so desires.

Interrupting characteristics of the two types of fuses are similar, *Fig.* 12. At high currents, the high-interrupting capacity fuses interrupt faster, whereas at moderate overloads the NEC fuses interrupt faster. This difference in tripping characteristic is not recognized at present in the *Code,* but it may be at a later date.

Proper thermal protection of the controller, especially in preventing burn-out of the overload relay heaters, requires that breaker and fuse ratings be properly co-ordinated with motor size. The *Code* has established rather definite rules on the breaker trip and the fuse ratings which may be employed, TABLES 7 and 8. If it is impossible to meet the established requirements because of unavailability of proper breaker trip or fuse sizes, or because of heavy starting duty, a higher current rating may be used which, however, must not exceed four times rated motor current. This limitation must be kept in mind, because control manufacturers are basing the design of their overload relay heaters on this rule, and the heaters would be damaged or destroyed, with possible short-circuits within a controller, if larger breaker trips or fuses were used.

SELECTION: Where should fuses and where should circuit breakers be used? The *Code* makes no choice between circuit breakers and fuses for short-circuit protection. However, certain considerations

Fig. 10—Tripping curve for a typical air circuit breaker shows operation to be nearly instantaneous at more than ten times rated current

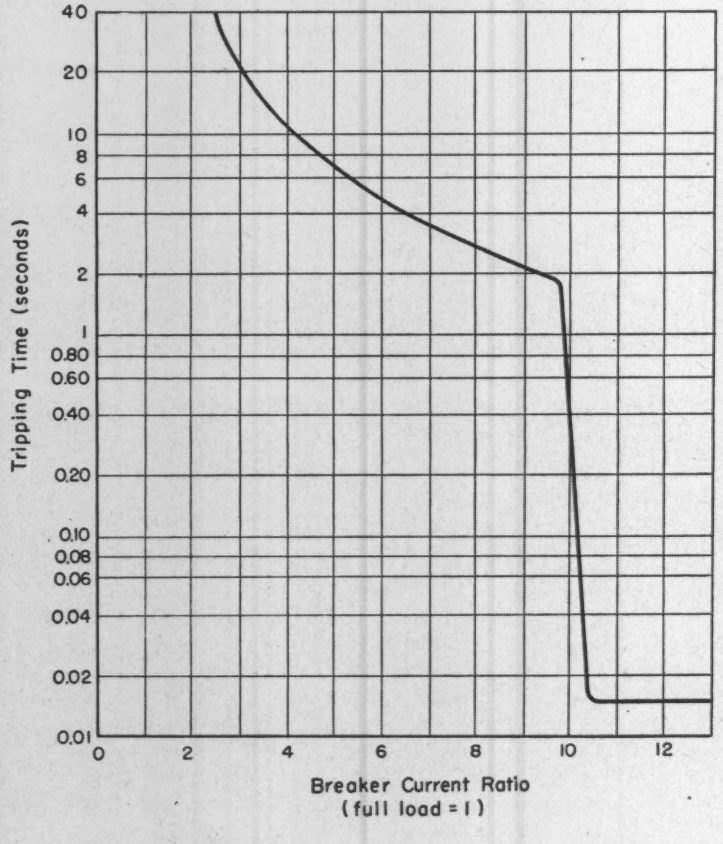
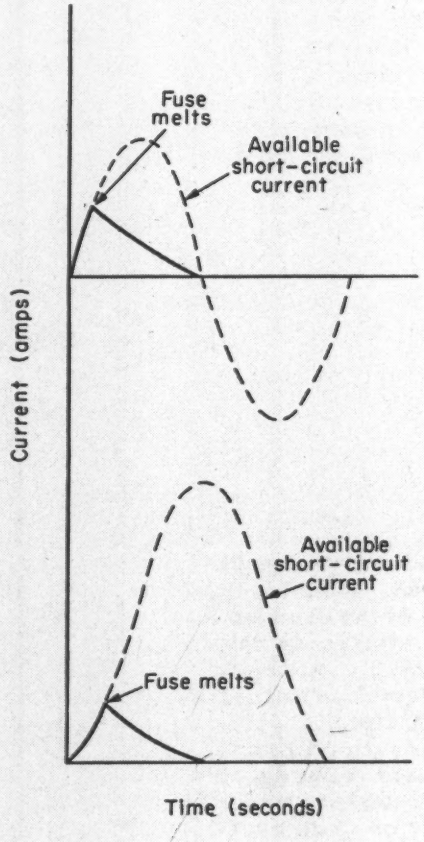


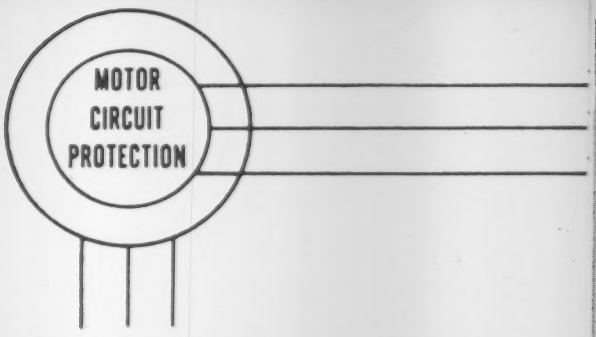
Fig. 11—Fuse characteristic does not allow current to reach its maximum value when short-circuits occur



may affect such a choice. Small motor starters, up to size 3, have limited thermal capacity. Overload relay heaters are wire-wound, and current-carrying parts have little storage capacity for heat due to the initial impact of short-circuit current. Since fuses interrupt current faster than circuit breakers under most conditions of short circuit, fuses are preferred for protecting small starters.

Since the smallest commercially available molded-case circuit breaker trip rating is 15 amperes, the *Code* requirement of four times motor full-load current cannot be met by circuit breakers if the motor full-load current is less than, say, 4.5 amperes, which corresponds to a 3-horsepower, 440-volt motor. This is an added reason why fuses are preferred for smaller sizes of starters since fuses can be obtained in lower current ratings than circuit breakers.

Many users prefer circuit breakers because their use eliminates the inconvenience of having to replace fuses. Motor starters of size 4 (150 amperes) and larger have considerable heat storage capacity. Overload relay heaters have conducting parts of larger cross-section which are able to stand considerable heat shock due to initial short-circuit current. Hence, circuit breakers are preferred for starters size 4 and larger.



Group Protection: As a general rule, the *Code* requires that each branch-circuit serve only one motor. In other words, each motor branch-circuit shall be protected individually against short-circuit currents. A special situation exists, however, in connection with machine tools, where one main motor such as a cutting motor may work in conjunction with several small auxiliary motors driving, for instance, coolant or lubricating pumps. On such a multimotor machine, the inadvertent stopping of an auxiliary motor on account of a fault in its branch-circuit, without stopping the other motors, may introduce a severe hazard not only to the machine, but also to the operator. Tool breakage or work breakage may not only entail a monetary loss; it may also cause injury to the operator.

To avoid this dangerous condition, several motors may be connected to one branch-circuit, pro-

Fig. 12—High interrupting capacity or current-limiting fuses interrupt faster at high currents than do ordinary NEC fuses. NEC fuse interrupts more quickly at moderate overloads

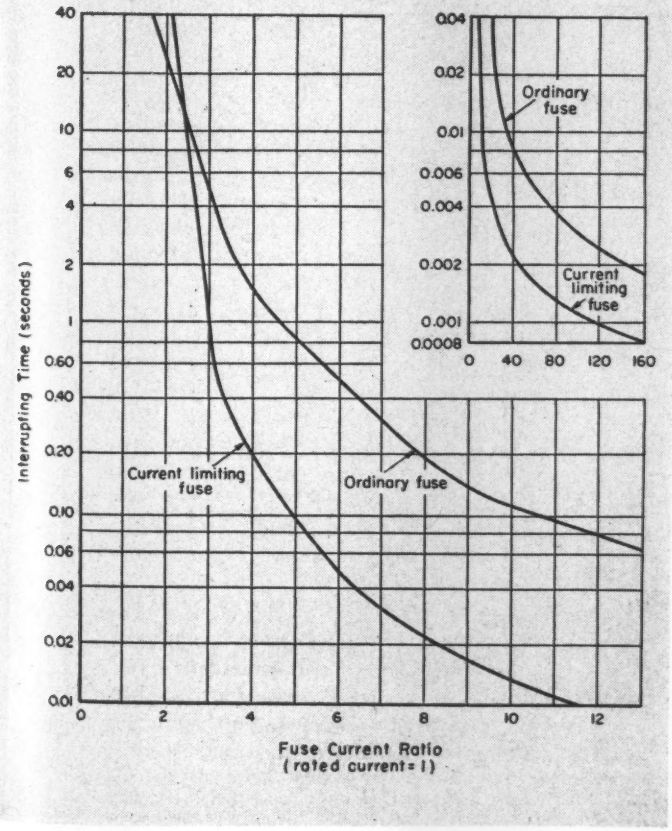


Table 7—Maximum Current Ratings for Ac Motors

(Not marked with code letter)

Type of Motor	Fuse Rating (% full-load current)	Circuit Breaker Trip Setting (% full-load current)
Single phase	300	250
Squirrel-cage and synchronous, full-voltage primary resistor and reactor starting	300	250
Squirrel-cage and synchronous, autotransformer starting		
up to 30 amperes	250	200
above 30 amperes	200	200
High-reactance squirrel-cage motors		
up to 30 amperes	250	250
above 30 amperes	200	200
Wound rotor motors	150	150

Table 8—Maximum Current Rating for Ac Motors

(Marked with code letter)

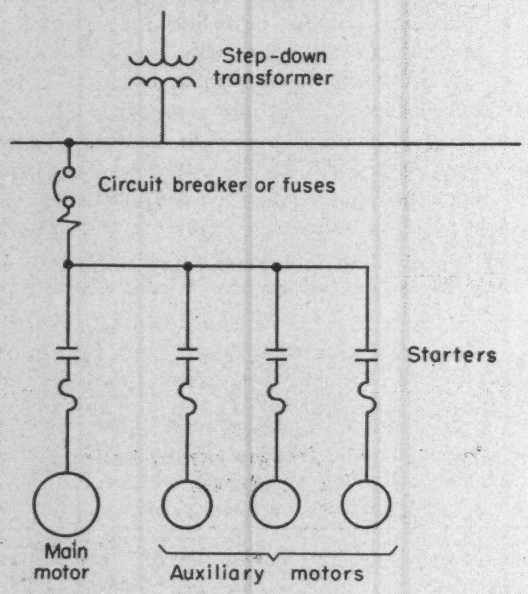
Type of Motor	Code Letters	Fuse Rating % full-load current)	Circuit Breaker Trip Setting (% full-load current)
All single and 3-phase squirrel-cage and synchronous motors with full-voltage resistor or reactor starting.	A	150	150
	B to E	250	200
	F to V	300	250
All squirrel-cage and synchronous motors with auto-transformer starting.	A	150	150
	B to E	200	200
	F to V	250	200

vided all motors on one branch circuit on the machine tool normally are in operation at one time, *Fig.* 13. To limit the potential hazard which an overcurrent in one of the auxiliary motor circuits may entail, the *Code* limits the trip rating of the circuit breaker, or the size of the fuse used as a group protective device, to 200 amperes for voltages up to 250 volts, and to 100 amperes for higher voltages up to 600 volts.

Combination Starters: The *Code* permits the user to decide where he wants to install the short-circuit protective means. Circuit breakers or fused switches may be included in a switchboard, they may be mounted and wired as individual units, or they may be included in the starter.

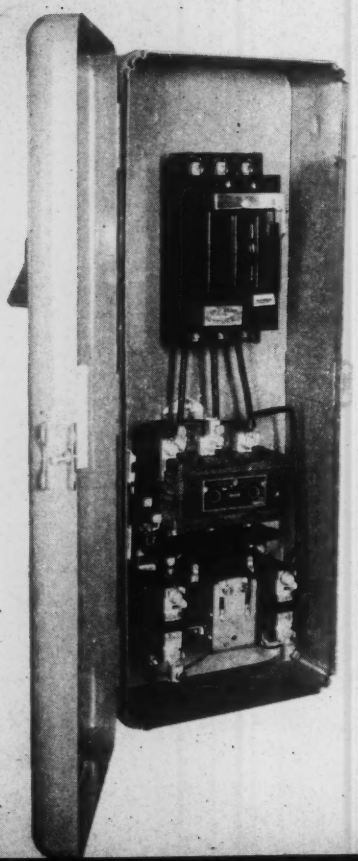
Combination starters are co-ordinated units, containing in one common housing the starter with motor overload relays, disconnecting means, and short-circuit protective means, *Figs.* 14 and 15. In a combination starter the control manufacturer offers a unit, properly co-ordinated, to provide complete protection of the motor and its branch circuit, as stipulated by the *Code.* Hence, the control manufacturer assumes the responsibility of selecting components that comply with the *Code.* In addition to conventional motor ratings, combination starters have an interrupting rating, which permits selection of a starter capable of handling available short-circuit current at the point of starter installation. In judging the interrupting rating of the starter, care must be taken to consider not only the interrupting ability of the breaker or fuses which actually do the interrupting, but also to pay proper attention to the co-ordination with the other components and the wiring, so that no damage will occur because of short-circuit current passed through the starter before interruption takes place.

Fig. 13—Several motors may be connected to one branch circuit provided all are normally operated at the same time



SAFETY IN HAZARDOUS ATMOSPHERES

Certain industrial locations involve peculiar additional fire hazards because of the atmospheres in which motors and control equipment have to



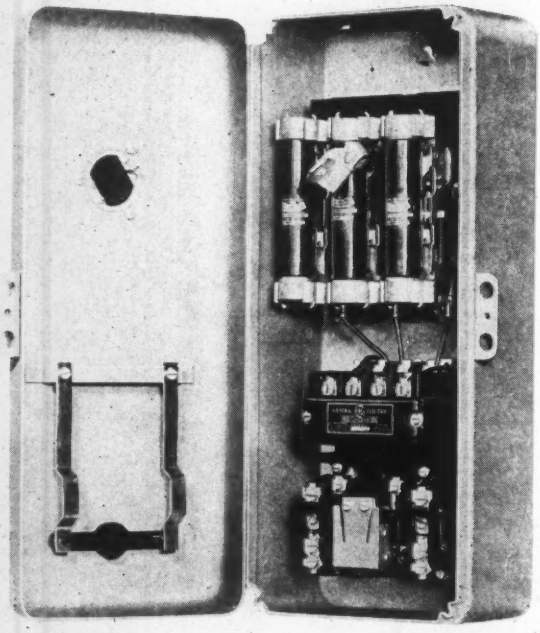


Fig. 14 — Extreme left —Combination starter combines overload relays, disconnect and short-circuit protective devices. Molded-case air circuit breaker in this starter can be operated from outside the enclosure with cover closed. Interlock prevents opening cover unless circuit breaker contacts are open

Fig. 15 — Left — Combination starter with fused motor circuit switch

operate. The additional hazards may be caused by presence of:

1. Flammable or explosive gases, vapors or dusts which may be ignited by arcs and cause a fire to be communicated to the outside of the control enclosure.
2. Easily ignitible material in the atmosphere which may be ignited by flames emitted from the enclosure.

For practical purposes, protection against hazardous atmospheres consists of providing enclosures to prevent flame from being emitted to the outside of the enclosure.

As an aid in specifying the hazardous conditions for which electrical equipment may have to be designed, the *Code* has established certain classes and groups of hazardous atmospheric mixtures on the basis of the degree of hazard involved. The *Code* also establishes two divisions for each class. Generally speaking, division 1 locations are those in which materials producing a hazardous atmosphere are manufactured or processed, whereas division 2 locations are those in which materials producing hazardous atmospheres are stored or handled in such a manner that an explosive concentration can only occur in case of abnormal operation or accident.

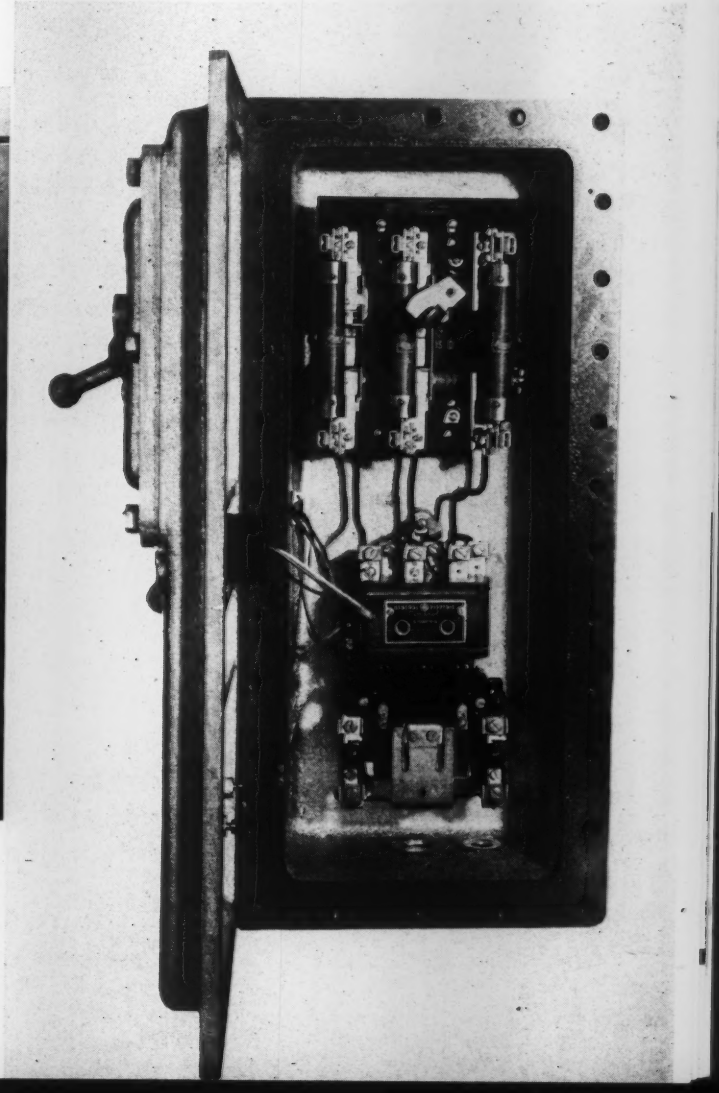
Class I Equipment: Class I locations are those in which flammable volatile liquids or flammable gases are manufactured or handled, such as:

- dry cleaning and dyeing,
- manufacture of pyroxilin plastics,
- manufacture of flammable gases and varnishes,
- distilleries,
- oil refineries,
- rectifying and blending of alcoholic liquors,
- manufacture of industrial alcohol,
- spray painting.

Motors with brushes, and controllers, must have arcing parts so enclosed as to meet approval by the Underwriters' Laboratories. Since the infiltration of explosive gas into the enclosure cannot be avoided, an explosion within the enclosure must not be communicated to the outside. Compliance with these requirements must be proved by an explosion test, or mechanical construction must comply with Underwriters' Laboratories design standards.

Controllers may be either air break or oil-immersed type. In air break controllers, arcs are interrupted in air. Enclosures for small controllers, *Fig.* 16, are made of cast or heavy-gage material,

Fig. 16 — Right — Combination starter for Class I, Group D location has heavy cast case



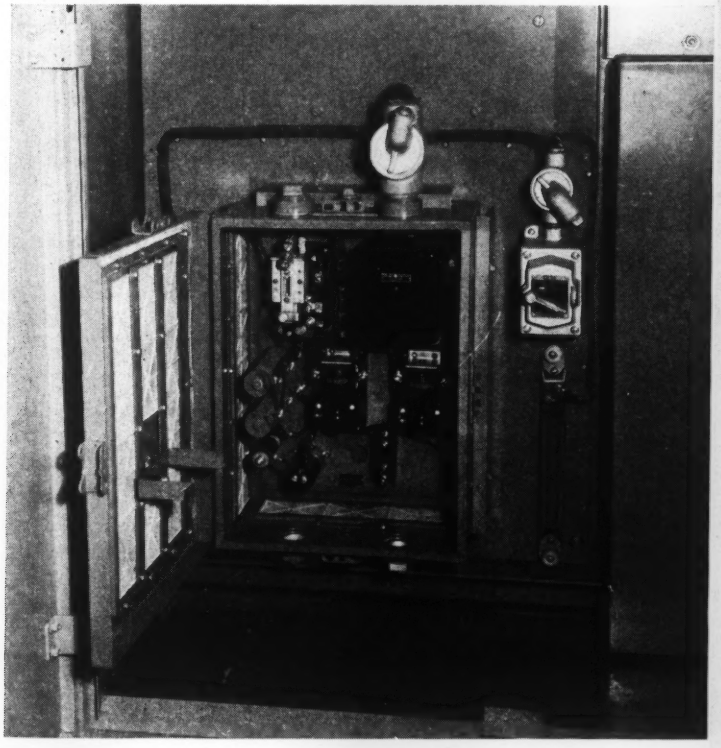


Fig. 17—Above—Enclosure of this combination starter has porous bronze walls to relieve pressure due to an explosion within the enclosure and prevent flame propagation through the walls

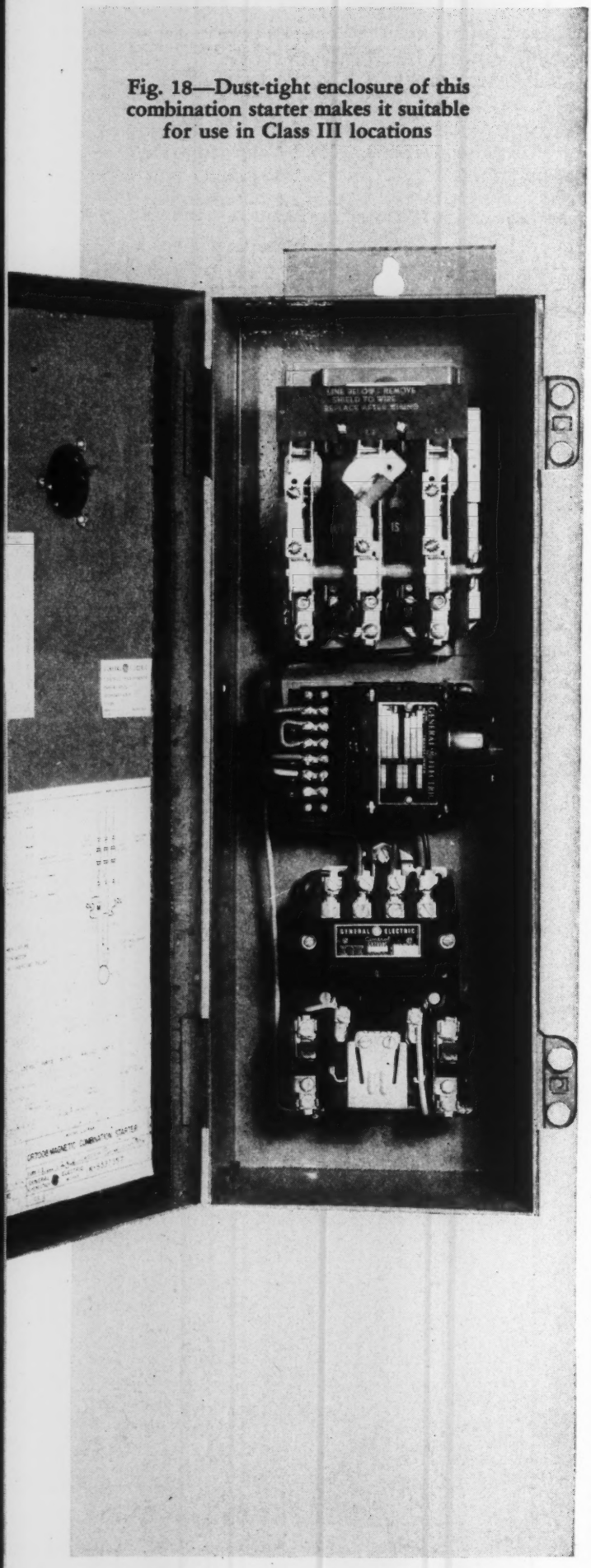


Fig. 18—Dust-tight enclosure of this combination starter makes it suitable for use in Class III locations

with wide metallic flanges and long sleeves for outside-operated parts. This picture shows a combination starter, and it is typical of the design used for small individual starters.

For large controllers, such an enclosure would be too heavy. Alternate enclosure, *Fig.* 17, has walls of porous bronze. Because of the porosity of the material, the high pressure of explosions within the enclosure is quickly relieved. However, as in old-time miners' lamps, flame is not propagated through the enclosure walls. Another alternative is the immersion of arcing contacts in oil, so that arcs do not contact the explosive atmosphere.

Class II Equipment: Class II locations are those in which combustible dust is thrown into suspension in the air in sufficient quantity to produce explosive mixtures. Also, such dust may accumulate on the outside to such an extent as to cause overheating, because of interference with normal radiation. Typical Class II locations are found in:

flour mills,
grain elevators,
starch plants,
sugar mills,
cocoa mills,
coal pulverizing plants.

Class II enclosures are so designed that dust must not enter, and the Underwriters' Laboratories standards prescribe mechanical detail. Gaskets, except for rubber, are permitted. Class I enclosures are generally suitable for Class II locations, except that oil-immersed equipment must be gasketed to prevent entrance of dust and consequent contamination of the oil.

Class III Equipment: Class III locations are those in which easily ignitable fibers and flyings are present, but in which such fibers or flyings are not likely to be in suspension in air in quantities sufficient to produce ignitible mixtures. In such locations the hazard consists primarily in fibers accumulating around and entering the enclosure, where such accumulations may be ignited from sparks or arcs. Typical Class III locations are:

rayon, cotton, and other textile mills,
fiber manufacturing and processing plants,
cotton gins and cotton-seed mills,
flax processing plants,
clothing manufacturing plants,
woodworking plants.

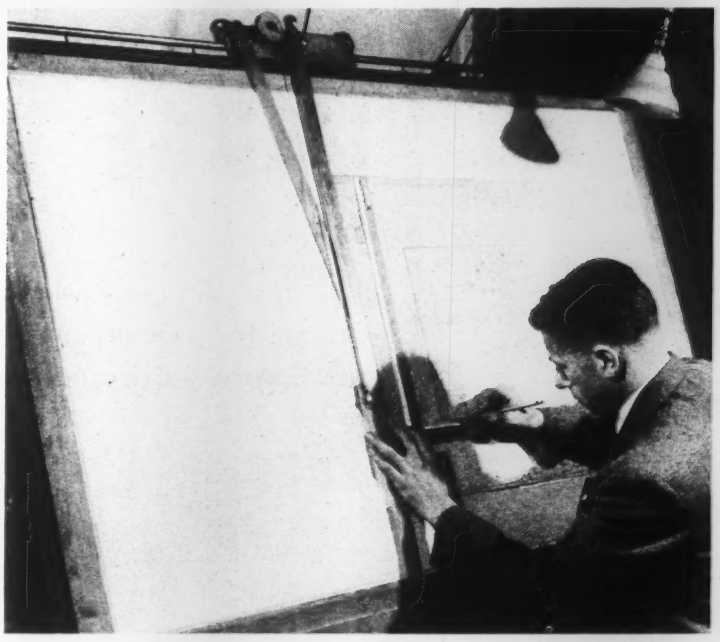
A typical enclosure, *Fig.* 18, has a gasketed cover, and all unnecessary openings are avoided. The seams are tight against entrance of dust.

Summary: Many provisions contained in the *National Electrical Code,* are not mentioned in this article. They pertain to a large extent to questions of installation over which the designer has no control, and which have no bearing on the design of machines. However protection against overcurrents and hazardous atmospheres must be considered in the selection of electrical equipment for powering and controlling machines. Consideration of *Code* provisions in machine design safeguards against possible accidents and insures acceptance of the equipment by fire underwriters and other inspection authorities.

Vertical Drafting Board

. . . a design for convenience and comfort

By Sigmund Rappaport
Project Supervisor
Ford Instrument Co.
Long Island City, N. Y.



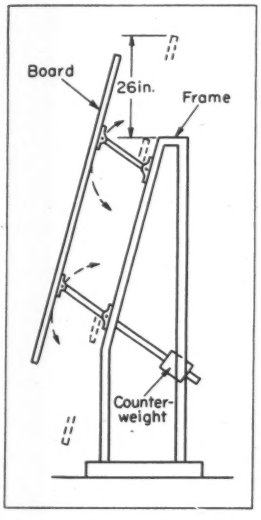


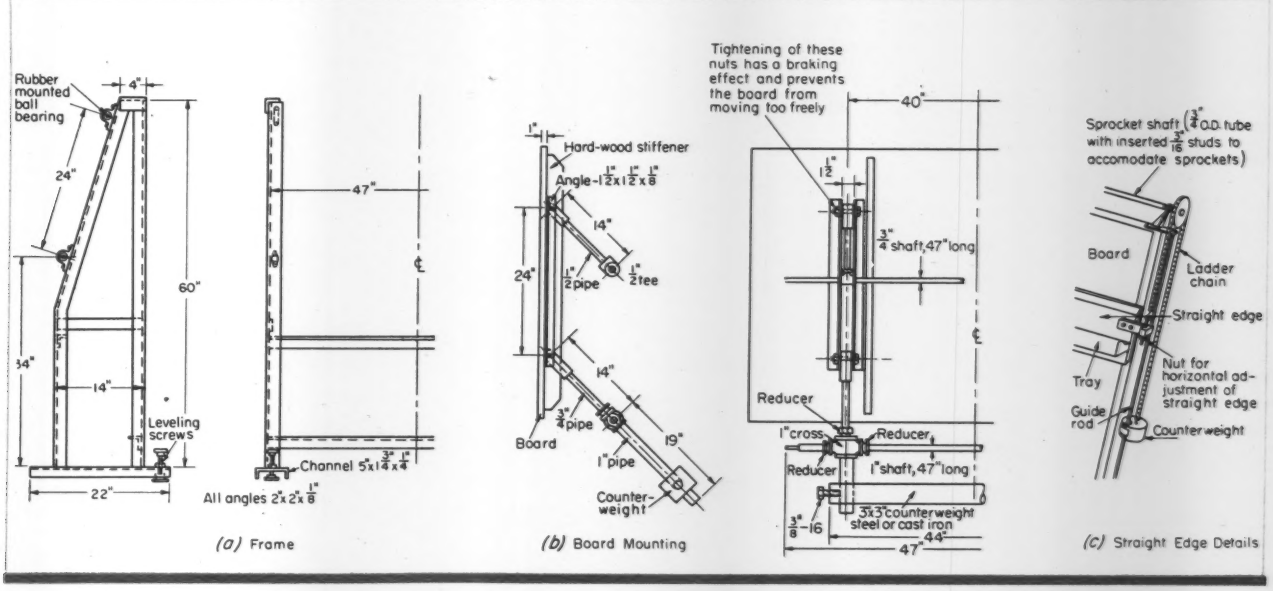
Fig. 1—Left — Parallelogram linkage allows 26-inch movement

CONSTANT bending over the usual horizontal drafting board imposes quite a physical strain upon a designer or draftsman. When working on the upper portion of a large drawing, he may have to reposition the paper on the board or work from the back of the board. An adjustable vertical drawing board eliminates the drawbacks of the horizontal board and permits the designer to work comfortably in either a standing or sitting position.

Such a board, *Fig.* 1, can be easily constructed. The welded angle-iron frame, *Fig.* 2*a*, will accommodate boards ranging in size from approximately 36 by 48 inches to 48 by 84 inches. Suspension system, *Fig.* 2*b*, permits 26-inch vertical movement of the whole board to simplify working at either extreme top or bottom of a drawing.

Drafting machines may be used with the vertical board or a straight edge, *Fig.* 2*c*, with a stiffening strip shaped to double as a tray for drawing tools, pencils, compasses, etc., may be easily constructed.

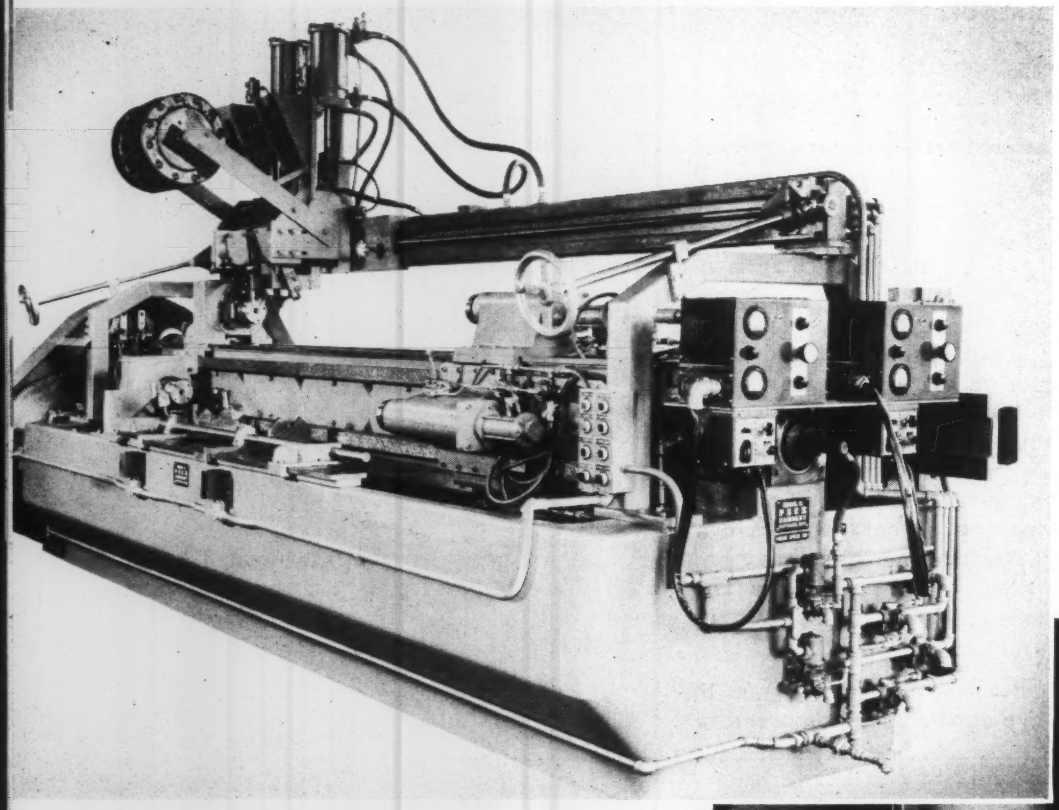
Fig. 2 — Below—Details of frame, *a*, mounting linkage, *b*, and straight edge, *c*



LARGE WELDMENTS

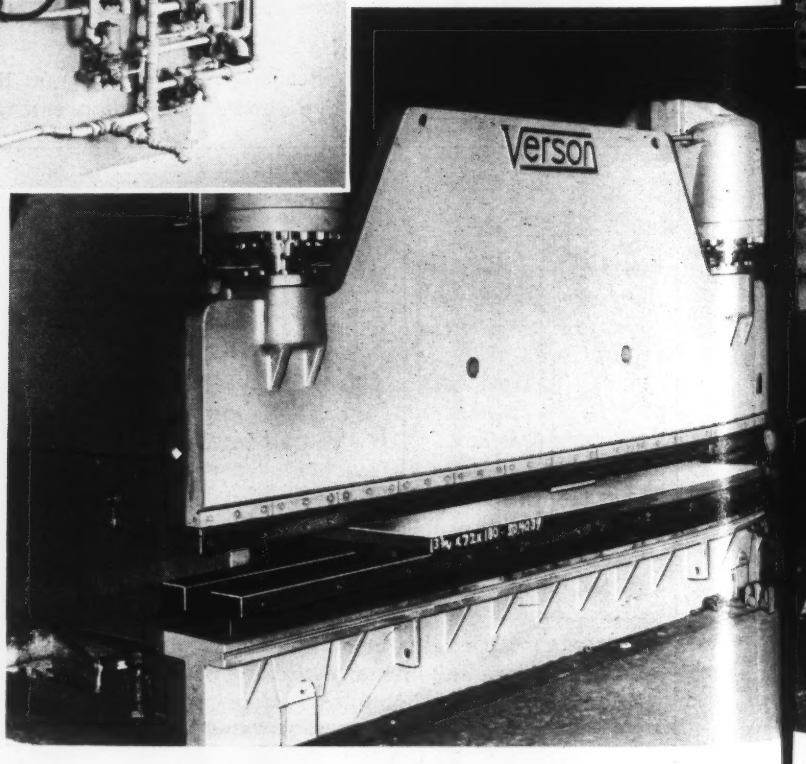
By J. B. Austin
Welding Engineer
Republic Structural Iron Works
Cleveland, Ohio

. . . how arc welding and plate forming influence design for lower cost, light weight and improved appearance



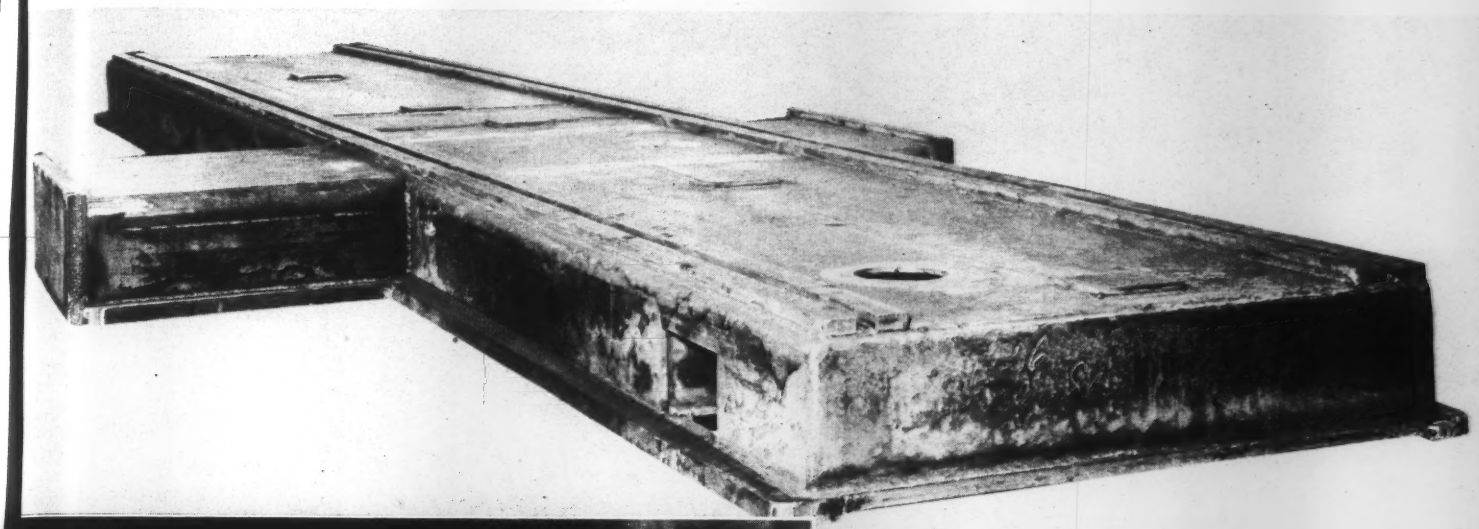
Brake forming and arc welding combined to produce the 7-ton bed of this four-station automatic welding machine built by Cecil C. Peck Co. for the Marion Mfg. Div., Dana Corp. Bed is 21 feet long, 5½ feet wide

Republic Structural's 1000-ton Verson hydraulic press brake on which all forming required for the illustrated examples was performed. Steel plate, 1-inch thick and 24-feet long can be formed to a right-angle bend

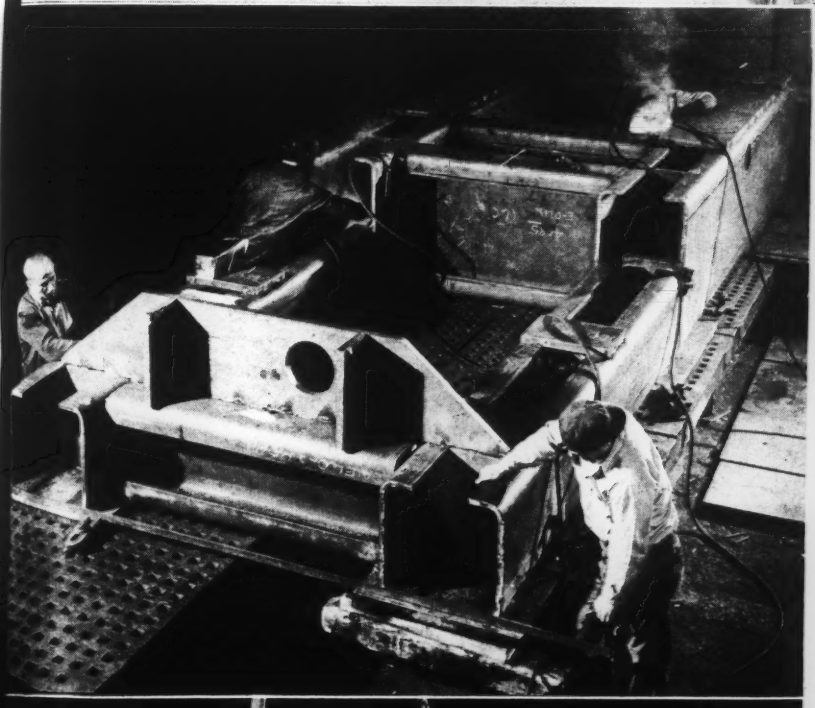


THE major objective in all weldment design is to fulfill all functional requirements with greatest simplicity, fewest possible parts, minimum weight and lowest cost. These attributes become particularly attractive in large weldments such as machine bases or beds.

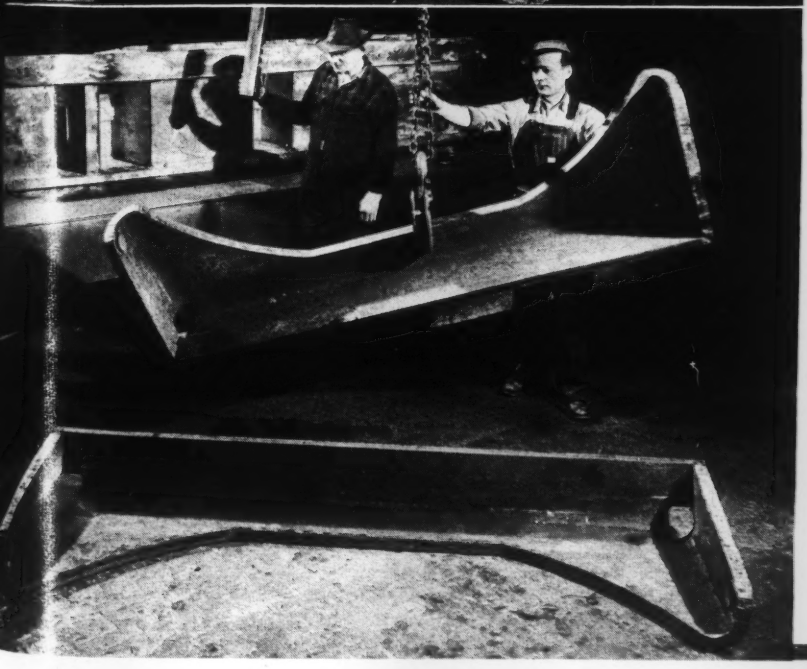
With a large weldment in mind, a designer usually chooses between two courses: (1) a design built up largely of standard structural shapes or (2) one comprised principally of plate. Combinations of the two, of course, are often



Channel-section of this bed was formed from 3/4-inch plate, 8-feet wide. Two such sections are welded at the center; total length is 36 1/2 feet; total weight, 12 1/2 tons. Cost of forming is more than offset by lower material and welding costs



This large bed, approximately 43 by 26 feet, is fabricated chiefly of 1-inch plate and weighs 16 tons. Required rigidity and attractive appearance are obtained with relatively few pieces. The component shown is formed from 1 3/4-inch plate and weighs 2070 pounds



practiced to good advantage.

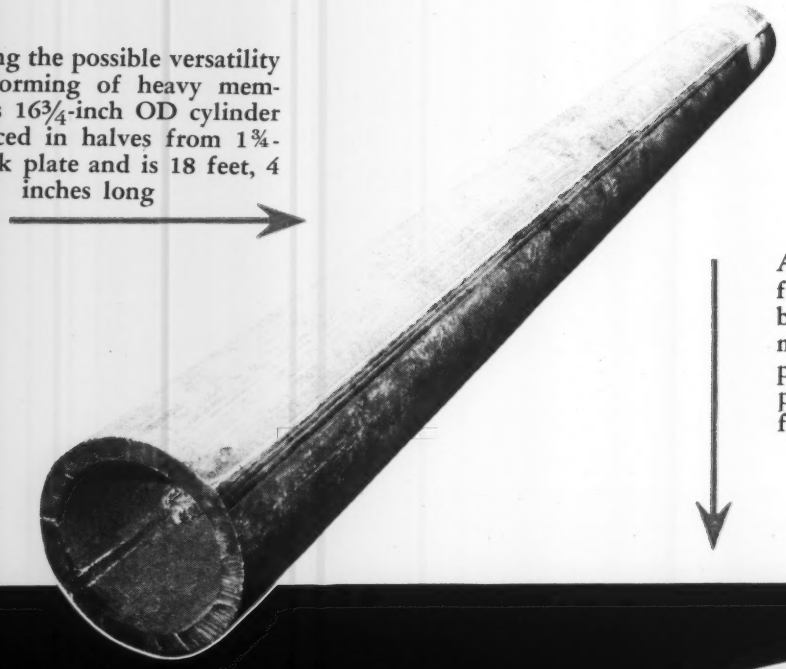
Frequently large, low, flat weldments are designed from standard structural shapes which develop great stiffness at low cost. Often a satisfactory functional solution, this method may lead to a design requiring more pieces and greater total weld length than desired. Moreover, rather obvious limitations upon aesthetic appeal are imposed.

Designing with plate formed to desired shapes is a more versatile approach and is being employed quite successful in the smaller range of weldment sizes. Frequently fewer pieces can be used and weld length is less. Also, there is greater freedom in designing for appearance. Formerly this avenue was not open to designers of weldments ranging upward from 5 tons total weight because of the difficulties involved in forming the required thick, long plates.

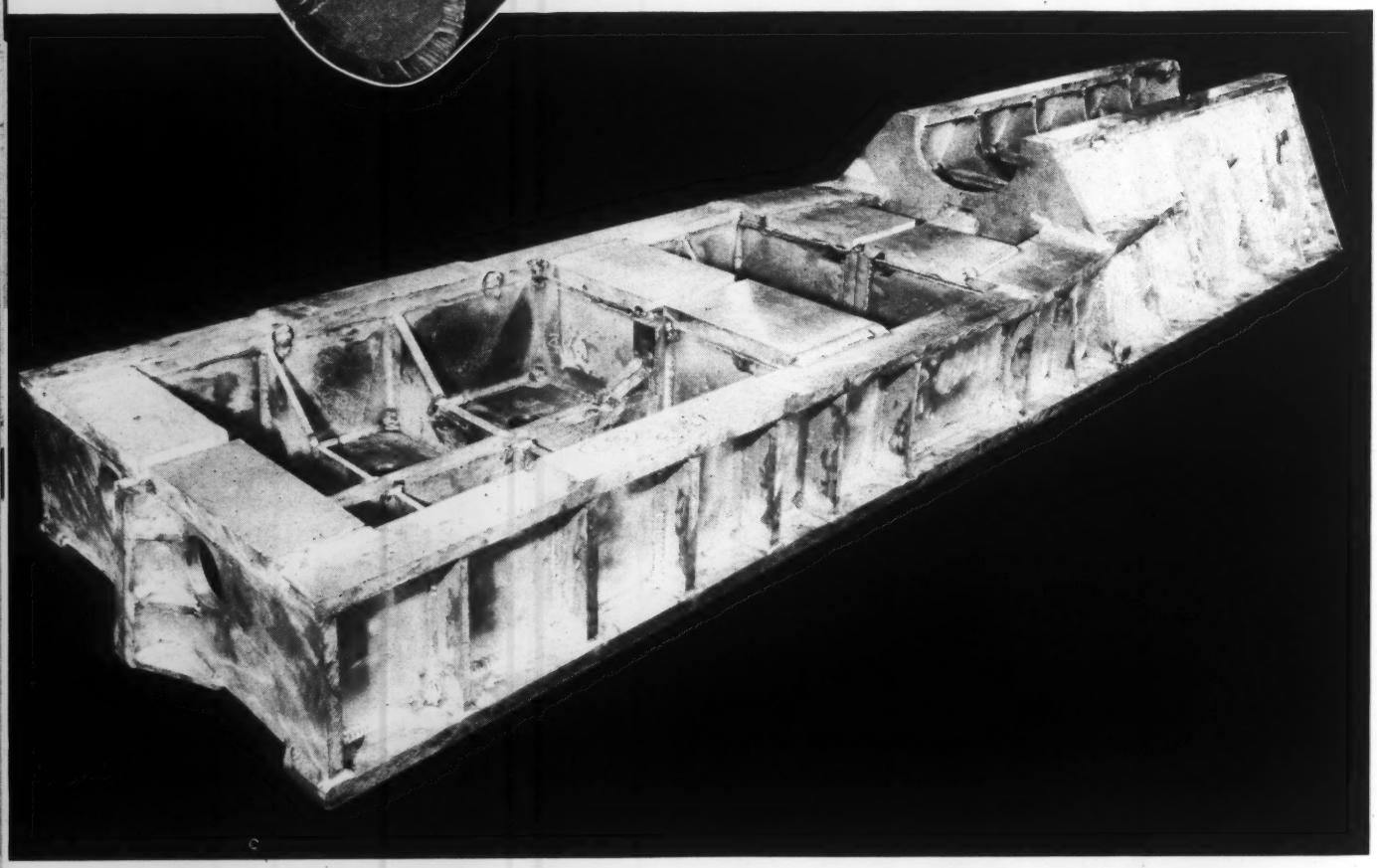
Essentially eliminating this problem,

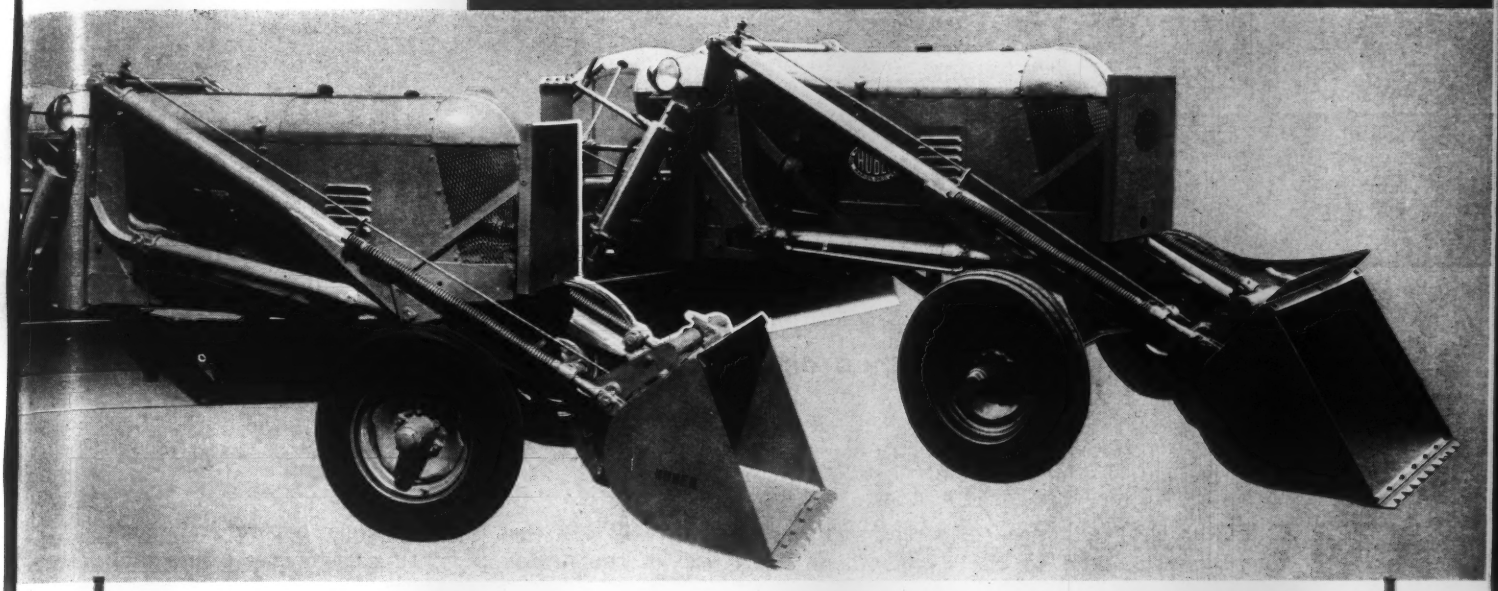
however, the recent development of large-capacity press brakes has made practical the combining of forming and arc welding so successfully practiced in smaller weldments. The examples presented in this article characterize the influence of this development upon the design of large weldments.

Suggesting the possible versatility in the forming of heavy members, this 16¾-inch OD cylinder is produced in halves from 1¾-inch thick plate and is 18 feet, 4 inches long



A striking example of large nonferrous weldments, this 2¼-ton bed is fabricated entirely of aluminum. It is constructed principally of 1¼ and 1¾-inch thick plate, and is approximately 22 feet long, 5 feet wide, and 2½ feet high





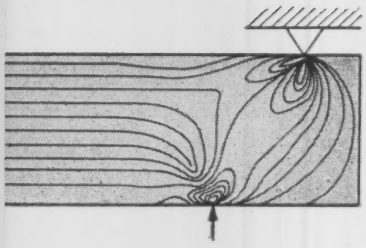
Bucket Loader Redesigned for Higher Stresses

SEVERAL STEPS were necessary to obtain an optimum design for a bucket loader developed by Huber Mfg. Co. Original loader operated satisfactorily but several weak points developed, particularly on overloading. Lift beams and cylinders are pivoted on steel support castings mounted on the tractor frame midway between the front and rear axle. Bucket is loaded and raised by these cylinders; the load is dumped by releasing a bucket latch and the bucket is returned by action of compression springs. Occasional overloading above the recommended 1000 pounds created excessive stresses on the tractor side frames, and shock loads caused by dropping loaded buckets in various positions of the lifting arc caused deflection and eventual distortion.

Revised loader, shown, was then designed to attempt to overcome these difficulties; however, with this design the lifting capacity of 1000 pounds was often insufficient to break loose a load from a stock pile, particularly if packed down. Since the tractor frame is incapable of sustaining a load greater than 1720 pounds at its center, increase in lifting capacity was not considered safe.

New design involves bent and welded tubing for main assembly. The loader proper is mounted on a subframe which spans the front and rear axles—essentially a tripod type of framework made from 1½-inch pipe. Thus loads are shifted from the tractor frame and placed squarely on the axles. Three almost identical cylinder assemblies are used, two for raising and lowering and the third for tripping. With the new design ⅜-cubic yard of earth weighing up to 2120 pounds can be manipulated, and "breaking-loose" force at the bucket lip in loading position is 4275 pounds — about four times that produced by the original loader. Cost of the redesigned unit is higher—approximately 24 per cent—but this factor is considered secondary in view of the increased performance.

Abstracted from an award-winning entry by Richard E. Acker, Huber Mfg. Co., in the James F. Lincoln Arc Welding Foundation Mechanical Design Award Program.



Stress Analysis in Design

By J. B. Hartman and R. E. Benner *Department of Mechanical Engineering Lehigh University, Bethlehem, Pa.*

MANY RECENT advances in stress analysis may be attributed to the development of effective experimental procedures. This phase, much like the body of theoretical methods complementing it, is quite extensive in all its ramifications, and the literature developed to date is quite complete. Hence the aim of this discussion is simply to outline and describe the relatively common experimental approaches and to indicate their appropriateness for different design situations.

Photoelasticity

Photoelastic stress analysis is of special interest because it has served as a link between the mathematical theory of elasticity and experimental procedures.[1] It is unique among the experimental methods in showing distribution of stresses throughout the section. Tests are performed on relatively low-cost scale models before construction of the prototype. The usefulness of this tool was, until recently, largely restricted to two-dimensional cases. Developments in new materials and techniques are extending the application of the method to three-dimensional problems.

Two-Dimensional Photoelasticity: Certain plastics have the remarkable property of becoming double-refracting when stressed. Incident polarized light rays are resolved into component rays in the direction of the principal stresses. Furthermore, the component rays undergo velocity changes proportional to the magnitude of the principal stresses. Phase differences in the waves emerging from the stressed material can be utilized in such a way that no light is transmitted at certain points in the model. The loci of these points form bands or fringes which represent contour lines of constant values of the differences of the principal stresses. When monochromatic polarized light is used, the fringe configuration appears as light and dark bands, *Figs.* 12, 13 and 14 (Part 2, April issue). The pattern of fringes is unique for each particular type of load and shape of model.

In two-dimensional stress investigations, the model is cut from a flat sheet of a suitable material. It is loaded in the desired manner in a

[1] References are tabulated at end of article.

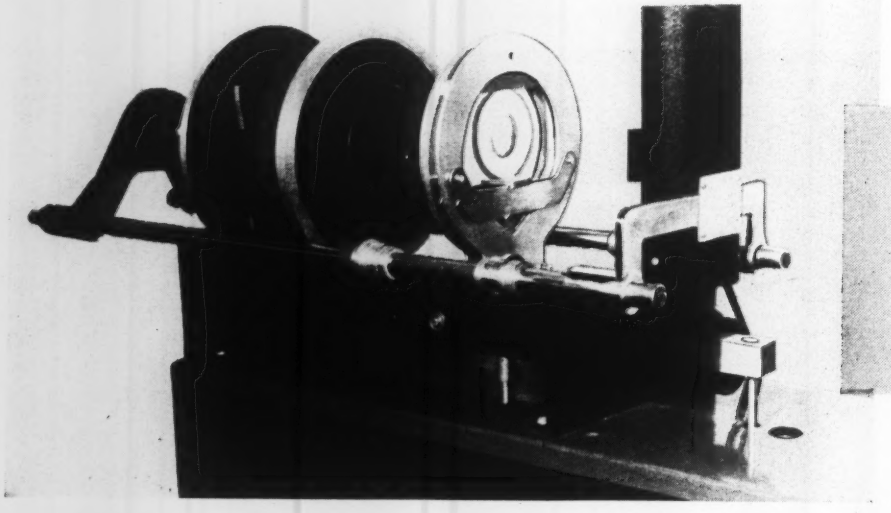
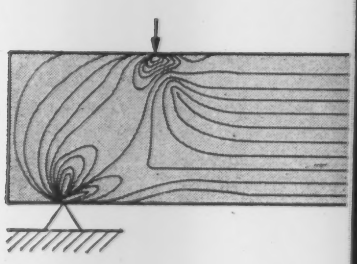


Fig. 24 — Photoelastic polariscope

Photo, courtesy Chapman Laboratories



Part 3—Experimental Methods

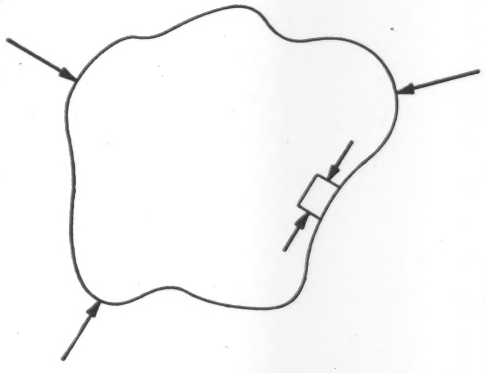


Fig. 25—Stresses at free boundaries

conveniently designed frame. The instrument used to obtain polarized light and to produce the stress pattern is termed the polariscope, *Fig.* 24. The components include a light source, polarizer, analyzer (similar to polarizer), quarter-wave plates (for circularly polarized light), screen for observing fringe pattern and generally a camera for photographic recording. When the quarter wave plates are removed, plane polarized light is available for locating isoclinics. The isoclinics provide data for plotting the directions of the principal stresses. Isoclinics represent lines of constant inclination of the principal stresses.

As previously stated, the component rays in the direction of the principal stresses undergo velocity changes proportional to the magnitudes of the principal stresses. This may be expressed mathematically by the so-called stress-optic law, based on experimental evidence. Thus

$$R = Ct\ (s_u - s_v) \quad \ldots\ldots (29)$$

where R = retardation in wave lengths, C = a coefficient for the particular material, t = thickness, and s_u and s_v = principal stresses. When the axes of polarization of the analyzer and polarizer are crossed (dark background), no light is transmitted to the screen for integral numbers of wave lengths. When the axes are parallel, extinction of light occurs for odd numbers of half wave lengths. Black fringes represent fringe orders of 1/2, 3/2, etc. A light background assists in defining the boundary.

The stress-optic law is more conveniently expressed in terms of a material fringe value rather than the coefficient C. If the material fringe value f is defined as the stress differential in pounds per square inch to change the retardation one fringe at a point in a model 1 inch thick, and if n = fringe order at a point, then

$$s_u - s_v = \frac{nf}{t} \quad \ldots\ldots (30)$$

For a given model, let $f/t = F$, called the model fringe value and easily determined from a calibration such as a pure tension test. Then $s_u - s_v = nF$.

As shown in the *Appendix,* Part 1 (March issue) the maximum shear stress may be expressed in terms of the principal stresses:

$$s_{uv} = \frac{s_u - s_v}{2} \quad \ldots\ldots (31)$$

from which

$$s_{uv} = \frac{nF}{2} \quad \ldots\ldots (32)$$

This indicates that the locus of points on a constant fringe order is also the locus of points of equal maximum shear stress. Thus a knowledge of the stress pattern and the fringe value permit the evaluation of the shear stress throughout the model.

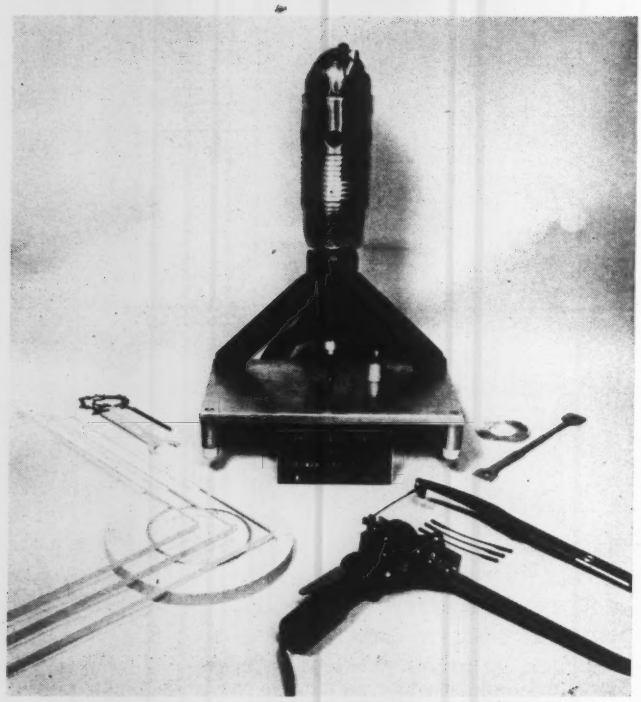
Of further practical interest is the fact that on free boundaries one of the principal stresses becomes zero. Consider the element in *Fig.* 25, free from external load. The faces are free from shear stresses; hence the faces are principal planes and the normal stresses are principal stresses. Since one of them is zero, there is only one principal stress at the free boundary and its direction is tangent to the boundary. Then from Equation 30,

$$s_u = nF \quad \ldots\ldots (33)$$

Thus the stress pattern reveals the principal stresses at the free boundary. Since in most practical cases the maximum stresses occur on the boundary, this readily attained information generally is sufficient for the designer.

Where it is necessary to separate and evaluate s_u and s_v on the interior of the model, more involved and time-consuming techniques are required. These methods are extensively treated in various excellent references on the subject.[1]

Applications of the photoelastic method may



Photo, courtesy Chapman Laboratories

Fig. 26—Photoelastic model-making kit

be summarized as follows:

1. Determination of maximum shear stress distribution.
2. Obtaining directions of principal stresses from isoclinics.
3. Evaluation of boundary stresses.
4. Determination of principal stresses throughout the model, generally requiring auxiliary tests.
5. Evaluation of localized stresses at discontinuities, a function of the geometry of the piece. Results generally expressed in terms of stress concentration factors which represent a ratio of the maximum stress at the discontinuity to a convenient nominal stress at some "regular" region well removed from the irregularity.

The difficulties of the two-dimensional method are generally associated with the properties of the material from which the model is cut and with the actual cutting techniques. Ideal photoelastic materials must be transparent, machinable, and free from initial or time stresses. They must also possess good optical sensitivity, relatively high tensile strength and modulus of elasticity. In preparing the model, the edges must be cut (not rubbed) with sharp cutting edges at high cutting

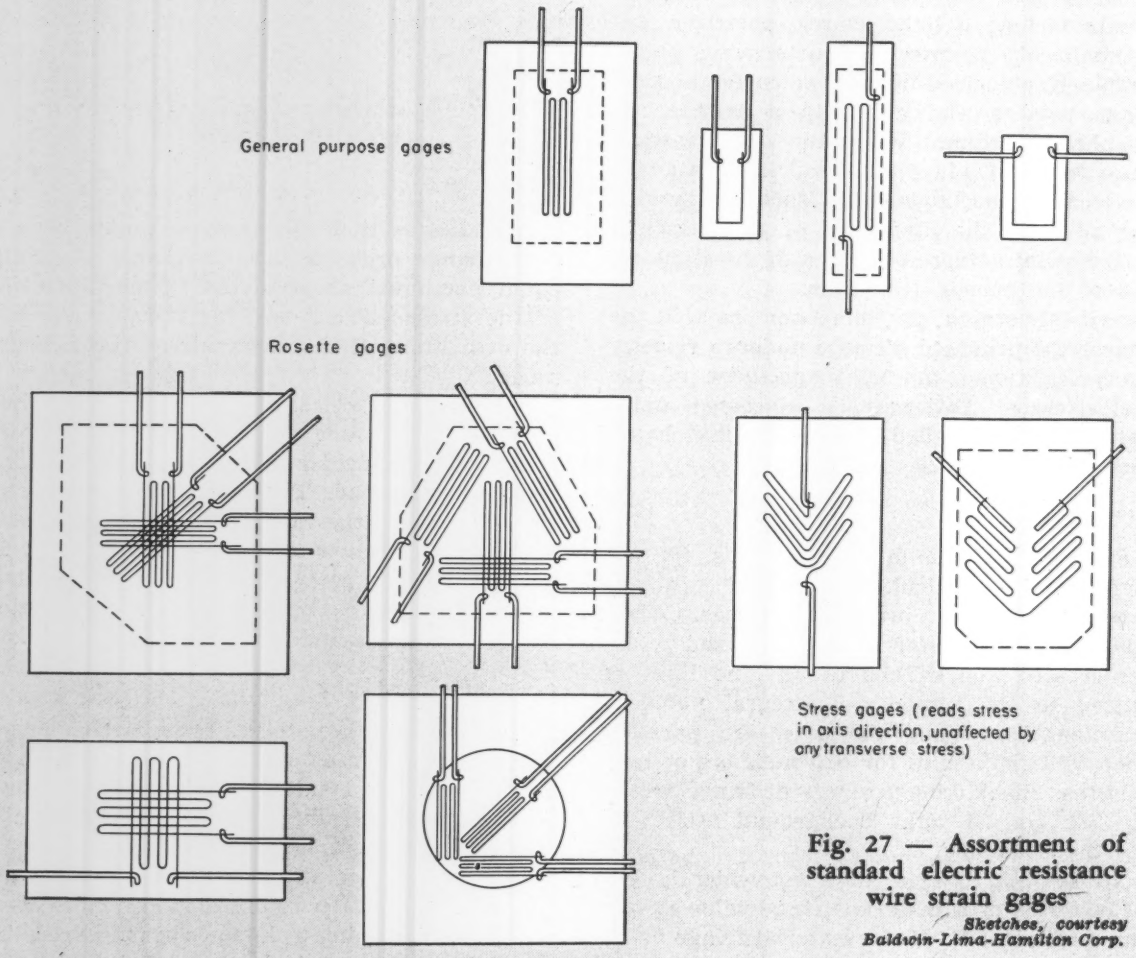


Fig. 27 — Assortment of standard electric resistance wire strain gages

Sketches, courtesy Baldwin-Lima-Hamilton Corp.

speeds. *Fig.* 26 shows a model-making kit now on the market.

Practically all published work on photoelasticity has been done for the case of static loads, a limitation, of course, as far as machine components are concerned. A polariscope has recently appeared on the market using a stroboscopic source of light to permit photography of stress patterns resulting from dynamic loads. This may greatly extend the usefulness of the method for the designer.

The outstanding characteristic of photoelasticity is its ability to give stress distributions throughout a section, including remote regions. The stress picture is presented in a memorable and dramatic fashion. As the load is applied to the model examined in the polariscope, the first fringe will appear at the point where the structure is most likely to fail. Increasing the load brings a repetition as higher order fringes appear at the "hot spots" and the lower-order fringes move slowly into the less critical areas. Regions of low stress are of practical significance where weight reduction is important. Models can be readily modified so that effects of structural changes may be determined easily and inexpensively.

Three-Dimensional Photoelasticity: Techniques for three-dimensional work have developed along the lines of the "frozen" stress method, in which the model is heated to a critical temperature range, then loaded similar to the prototype and slowly cooled under load. At room temperature the load is removed, but a system of fixed or frozen strains is retained in the model. It has been demonstrated that the frozen strains are typical of the elastic state of stress. The model is sliced in suitable planes. The slices are examined as two-dimensional specimens. If done carefully, slicing does not disturb the frozen stress pattern.

Development of both two and three-dimensional photoelasticity has been closely allied with the availability of suitable materials for models. Two dimensional work surged forward when the production of a cast phenol plastic (Catalin C-61-893) displaced glass and celluloid for this purpose. The development by Westinghouse Electric Corp. in 1947 of a styrene-alkyd resin known as photoelastic Fosterite has been a great boon to three-dimensional work. Whereas Catalin is available in plates of maximum thickness of 1 inch, Fosterite has been cast in 3-feet long cylinders of 6-inch diameter. Thus larger and more accurate models may be made. Furthermore, the slicing technique is aided since the slices may be thinner with respect to the overall dimensions. Fosterite has also shown marked superiority in the elimination of the time edge-effect stresses.

Photoelasticity is practically the only available technique for the experimental investigations of three-dimensional stress problems. The investigator must be cognizant of two possible sources of error in three-dimensional work. Stress distribution in the model and prototype may differ somewhat in these cases due to differences in elastic constants, such as Poisson's ratio. Care must be taken, particularly in frozen stress tests, in order that the strains in the model do not become large enough in comparison with the metal prototype to alter the geometry of the problem.

When due account is taken of the possible sources of error inherent in the method, photo-

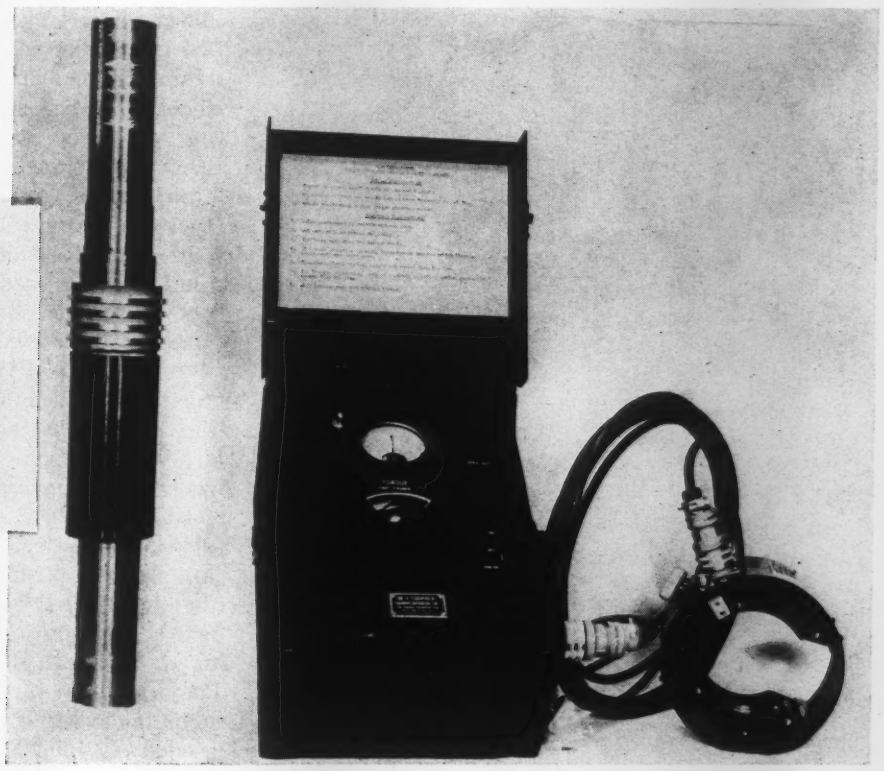


Fig. 28—Torque meter, with slip rings, commutator, and indicator

Photo, courtesy Baldwin-Lima-Hamilton Corp.

elasticity presents a means of verifying and extending theoretical procedures of stress analysis. Beyond this it serves in a qualitative sense as a powerful visual aid to the designer.

Strain Gages

By general definition, strain gages are devices utilized to measure linear deformations over specified lengths of the material composing structures subjected to load.[2,3] Where the deformations are minute strains or displacements typical of elastic structural materials, some type of magnification is generally required.

The earliest strain gages were of the mechanical variety employing levers, gears, etc., for magnification. Reliability was limited by friction, backlash and inertia, particularly where rapid changes occurred in the motion to be studied. Optical gages, utilizing an infinitely rigid and weightless light beam, were developed to overcome these difficulties. Another solution involved the transformation of mechanical motion to changes in an electric circuit. As a basis of comparison, the factors to be considered in the selection of a strain gage include the following:

1. Size of the gage in relation to the size of the part.
2. Type of surface on which gage is applied.
3. Gage length.
4. Desired sensitivity and accuracy.
5. Effect of the gage upon behavior of the part.
6. Possible surface damage from gage attachment device.
7. Type of loading (static, dynamic).
8. Adaptability to recording.
9. Availability and cost.

Fig. 29—Load cell employing electric resistance wire strain gage

Photo, courtesy Baldwin-Lima-Hamilton Corp.

The mechanical type gages include the Huggenberger, Porter-Lipp, and Whittemore. The Tuckerman gage is of the mechanical-optical type using a collimated light beam. Purely optical strain gages are of the interferometer type such as the Vose gage. All these gages have limited usefulness in applications where relatively large gage size and weight cannot be tolerated.

By virtue of their accuracy in indicating surface strains, their adaptability to various surfaces and structures and the many possibilities in handling the gage output signals, the electric strain gage is one of the designer's most useful tools. Mechanical displacements can be utilized to vary either the capacitance, inductance or resistance of an electric circuit. Of these, the variable resistance strain gage probably has the widest application and will be discussed in some detail.

The resistance wire strain gage known as SR-4, *Fig.* 27, has in many cases replaced other strain gages. The gage consists of a length of fine wire usually bonded to a paper base. The gage is cemented to the part to be tested so that it is strained with the test piece in either tension or compression. The bonded wire, whose resistance varies with strain, is incorporated into an electric circuit. A measurement of the change in resistance becomes convertible to a measurement of the strain. The gage may consist of a single grid to measure strains in one direction, or two or more grids to measure strains in several directions. A combination of three or four grids having a definite angular relationship (i.e., measuring normal strains in at least three directions) can be used as a strain rosette to provide data for calculating the magnitude and direction of the principal strains. In this form it is used in biaxial stress investigations; that is, on the surface where the principal directions are unknown.

The sensitivity of the electric-resistance gage is about ten times that of most mechanical gages. The gages are inexpensive and may be used in large quantities. Approximately the size and weight of a postage stamp, they rarely change the characteristics of the piece to which they are attached. The electrical circuits used are such that the recording instruments may be located some distance from the test. The output may be recorded, sent by radio (telemetered) and may be amplified if the signal is used for control purposes. They may be used for static and dynamic tests including cases of impact and vibrations with frequencies of 50,000 cps or more. Satisfactory per-

formance is obtained from −100 F to 300 F. Actually, resistance type gages have been used at considerably higher temperatures. Since these gages operate up to 1 per cent strains, the structures may be tested to failure without alteration of original calibration. Gage lengths range from 1/16-inch to 6 inches.

Among the limitations of the method should be listed the need of specialized knowledge in electronics for the more complicated cases. Instrumentation may also prove costly in cases where the output is low for the intended purposes.

Residual stresses resulting from fabricating processes may be evaluated with electric-resistance strain gages. The general procedure is to drill or bore out material, and measure the strains resulting from the relief of the locked-in stress.[2,4]

The use of these gages in load determinations provides the designer with much-needed information. The general procedure is to place the gage on a convenient part of the structure which is calibrated by plotting gage output against known loads. Examples of this application are:

1. Torquemeters, *Fig.* 28, consisting of a gage mounted at an angle of 45 degrees to the shaft axis, used in conjunction with slip rings. Instantaneous torque variations in the shaft may be observed.
2. Measurements of connecting rod forces, useful in rod and bearing design in reciprocating machinery.
3. Measurements of loads exerted on frames and housings.
4. Impact loads.

Other instruments incorporating strain gages are load cells, *Fig.* 29, for determining weight of cumbersome assemblies, and also accelerometers, and torsiographs.

Brittle Lacquers

This method of stress analysis is based upon the characteristics of certain brittle coatings which develop visible cracks at predetermined values of strain.[2] Brittle lacquers, known as Stresscoat, are available commercially, *Fig.* 30.

These coatings which are applied to the surface by spraying may be used on the surface of all kinds of irregular shapes in three dimensions. The result is a strain gage of extremely small gage length, permitting investigations of small, critical regions at fillets, holes and joints not accessible to other means of measurement.

When the strain on the surface of the body under test exceeds a certain value, cracks develop in the lacquer in a direction perpendicular to the principal tensile strain, *Fig.* 31. By an observation of the regions in which the cracks first form as the loads on the part are gradually increased, the regions and directions of maximum strain are readily located. Compression strains may be examined by applying the coating while the part is under load and then allowing it to come to a neutral condition.

The technique has been extended to problems

Fig. 30—Complement of materials and equipment for strain determinations with brittle lacquer

Photo, courtesy Magnaflux Corp.

involving dynamic loads and to certain evaluations of residual stresses.

The use of brittle coatings yield some remarkable revelations of previously unsuspected concentrations of stress in an easily understandable manner. Hence it has great value as a demonstration tool in the shop. It serves as a valuable adjunct to strain gage studies since it tells the investigator where he should locate the gages. Its greatest value is as a qualitative rather than a quantitative measuring tool. Certain disadvantages lie in the sensitivity of the lacquer to temperature and humidity changes. A controlled atmosphere is desirable for critical work. In the case of errors of procedure or a desire to change loading conditions, the old coating must be removed and another applied. Since its application is restricted to the surface, no overall picture of stress distribution can be obtained as in the case of photoelasticity. Fortunately, in most design cases the surface stresses are most important.

Analogies

Design information can also be obtained by the use of analogies.[2] While this use has been somewhat limited in the past, its potentialities should be recognized and considered in future developments.

Similarities often exist between the basic mathematical equations describing certain physical phenomena, even though the phenomena themselves appear outwardly dissimilar. One of the phenomena may lend itself readily to experimental study while the other may not. Due to the mathematical similarities, the one case may be analyzed from a study of the other. For example, problems in torsion may be studied by a membrane analogy, a sand heap analogy, a hydrodynamical analogy or one involving measurements of electrical potential. Solutions have been obtained for many noncircular sections, shafts with keyways and other cases which present formidable mathematical problems.

An analogy holding promise to the designer is that existing between mechanical, acoustical and electrical systems. For example, a vibration problem could be solved by setting up an equivalent electric circuit which can be readily investigated. Many times this could be done in a relatively inexpensive manner. The electrical quantities of inductance, resistance, and the reciprocal of capacitance are equivalent to mass, damping factor and spring constant in the mechanical system.

General recommendations on how to approach specific design problems will be presented next month in the final article of this series.

REFERENCES

1. M. M. Frocht—*Photoelasticity;* Vol. 1, 1941; Vol. 2, 1948; John Wiley and Sons Inc., New York.
2. M. Hetenyi—*Handbook of Experimental Stress Analysis,* John Wiley and Sons Inc., New York.
3. G. H. Lee—*An Introduction to Experimental Stress Analysis,* John Wiley and Sons Inc., New York, 1950.
4. K. Heindlhofer—*Evaluation of Residual Stress,* McGraw-Hill Book Co., Inc., New York, 1948.

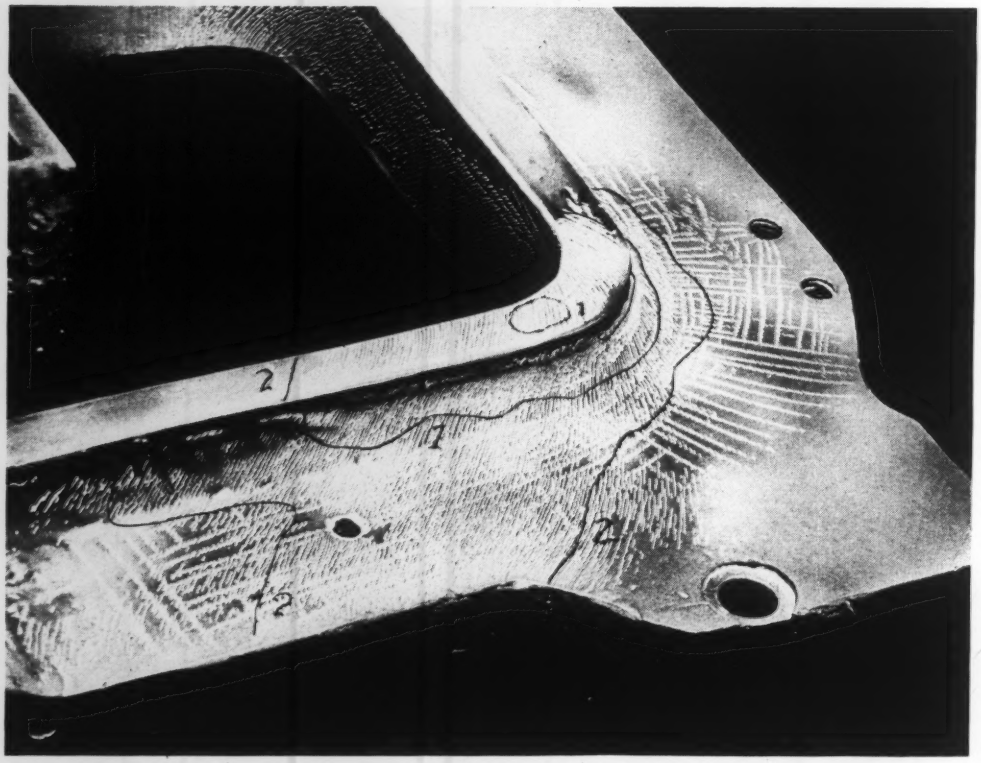


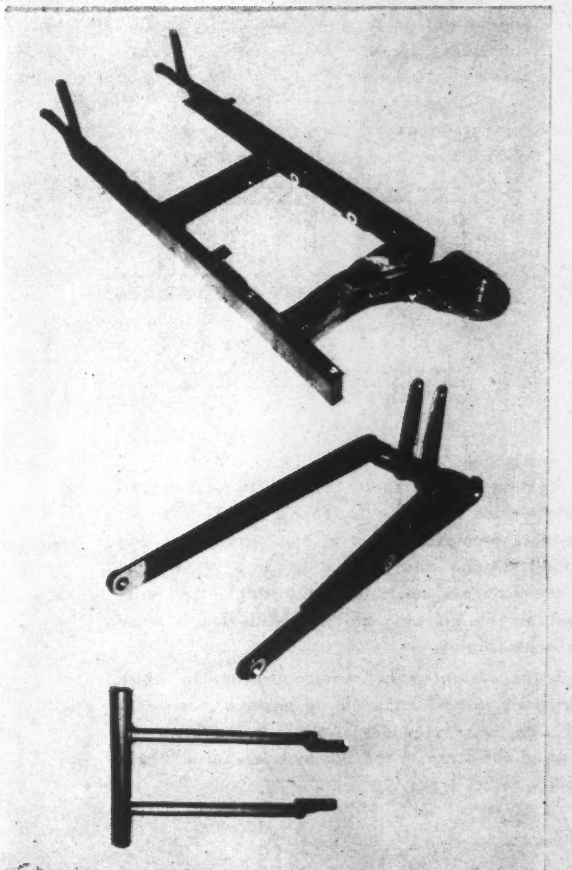
Fig. 31—Stress pattern developed in brittle lacquer coating applied to hand shear frame

Photo, courtesy Magnaflux Corp.

ACTUALLY THREE machines in one, the roof bolting machine developed by Chicago Pneumatic Tool Co. performs three separate functions in roof bolting of mines. With this method of fastening the roof of a mine into a firm structural unit, a hole must first be drilled, an expansion bolt pushed up into the drilled hole, and a nut tightened on the bolt. These three jobs are accomplished on the same machine by a motor-driven double-arm pantograph mechanism used as a jack and a motor-driven drill unit mounted on the outer arms of the pantograph which also incorporates a built-in impact wrench. This double function is achieved with a dual spindle—an inner high-speed spindle for driving bits and a geared outer low-speed spindle for nut setting.

CONTEMPORARY DESIGN

Welded Design for Roof Bolting Drill



Welded design has been used wherever possible for structural parts. Main chassis consists of a channel-shaped outer piece with a center brace. Plates are intermittent arc-welded along the inside for support and as bearing mounts. Uprights at the rear are pantograph arm supports. Front-end neck or wheel support is composed of flame-cut pieces arc-welded together. Parts, mostly of SAE 1020 steel, are machined before welding, and use of good welding jigs is credited with maintaining precision.

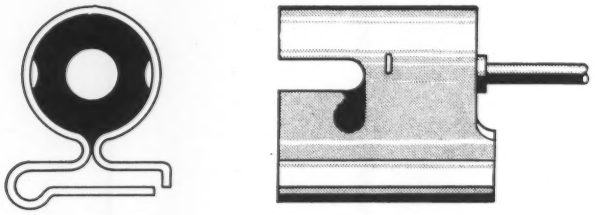
Pantograph elevating crank is operated by a jackscrew attached to the upright arms, which causes the long arms to rise. Upward pressure of 5000 pounds results from the system. The crank is built up of SAE 1020 steel plates with side bracing plates, all attached to an axle housing tube to which lever arms are also welded. Even though welded after machining, bearing mounting holes in the plate line up accurately.

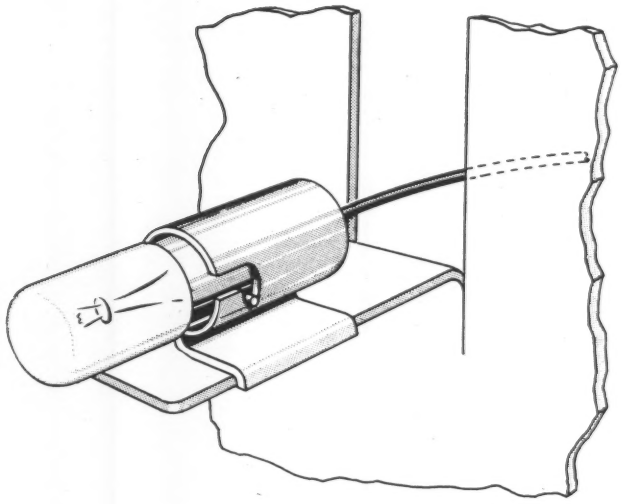
Bracket holds the elevating motor and jackscrew in line with the pantograph. Welded together of steel tubing and lugs, the assembly is held to extreme accuracy between centers.

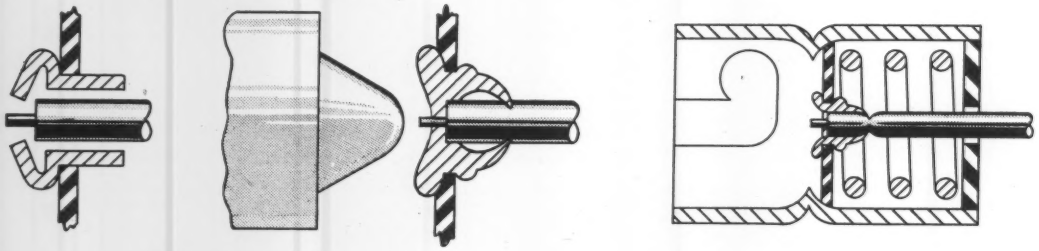
Adapted from an award-winning entry by Raymond F. Ball, Chicago Pneumatic Tool Co., in the James F. Lincoln Arc Welding Foundation Mechanical Design Award Program.

Dial-Light Assemblies

Ideally suited for panel illumination or visual indication and signalling, dial lights provide a convenient and economical localized light source which can be readily adapted to a wide variety of mounting and space requirements. Snap-in and slide-on units are of particular interest in design because of their simplicity in application and the advantages offered in ease of assembly and maintenance. Typical types and applications are depicted in the accompanying illustrations which show dial light socket assemblies manufactured by the Alden Products Co. Employing bayonet type bulb mounts, the sockets are available with one or two contacts and can be used with either filament or neon lamps. Integral leads facilitate installation and removal in service for lamp replacement. Several modified socket and lead arrangements are also available to meet special installation requirements.

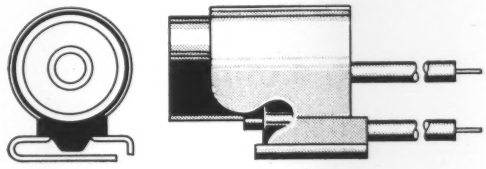


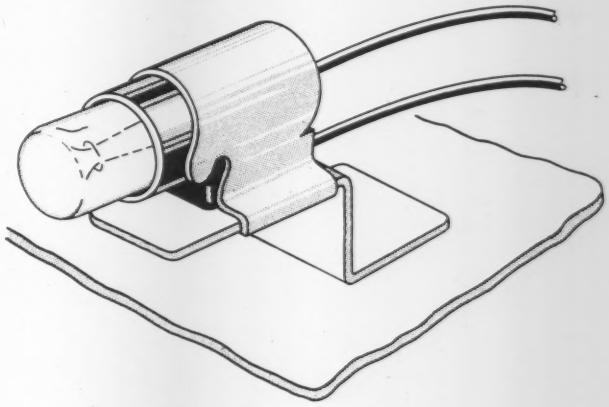




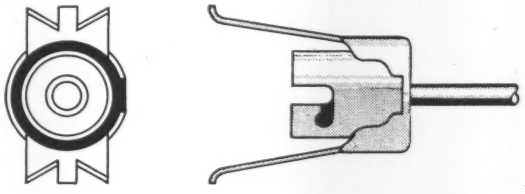
Basic slip-on socket type for edge or back lighting can be readily mounted to tab punched from panel, as shown, or to "L" or "Z" bracket which has been fastened to the equipment chassis by spotwelding or other means. One-piece stamped design of lamp receptacle and clamp assures alignment of socket and mounting bracket and permits welding of shell to bracket for permanent attachment. Electrical connection is by means of a single lead wire with the mounting surface serving as the ground. Sockets are also available with double leads where direct grounding to mounting bracket is not desirable.

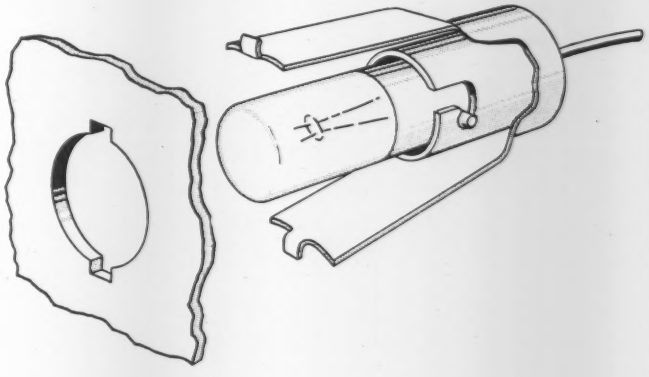
Solder connections have been eliminated in the design by a novel construction in which the lead wire ends are crimped and clamped securely in position, assuring positive center contact with the lamp and reducing tendency of wire to short under strain. In addition, the contact base is spring loaded to facilitate locking of the lamp in the bayonet receptacle. These construction features are also common to the other socket types.



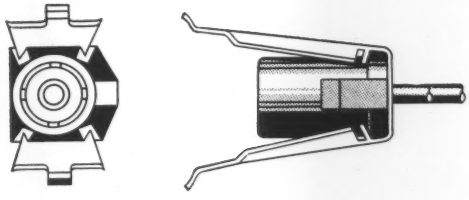


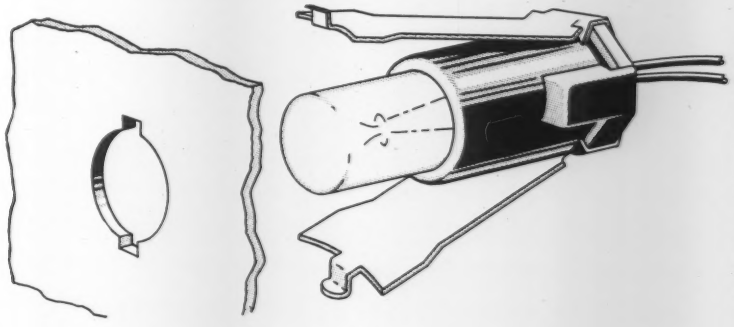
Insulated slip-on type has two leads for electrical connection and is designed for ac or dc installations where chassis grounding is impossible. Similar in construction to the basic type, it can also be tab or bracket mounted; a typical "Z" type bracket mounting is shown. The insulation, which is of a molded phenolic type, is locked positively to the one-piece stamped shell.



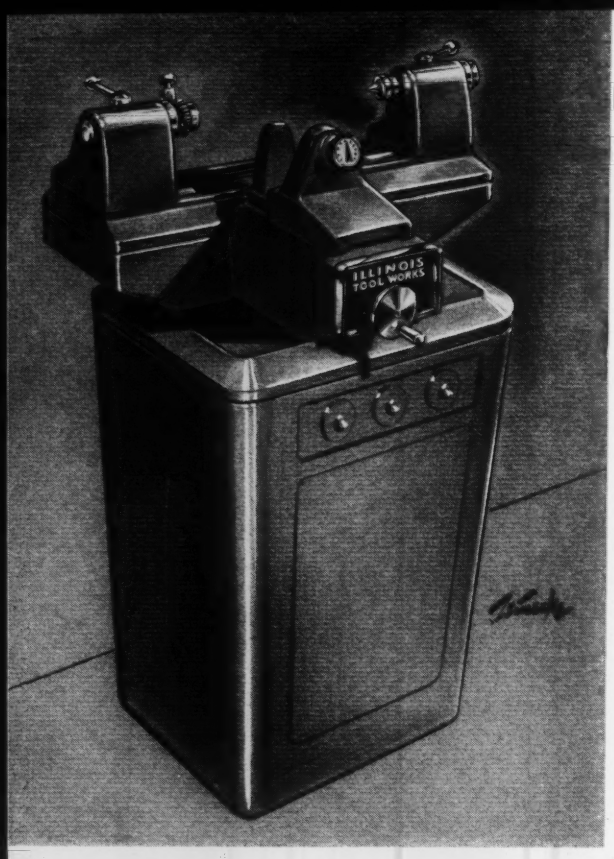


Basic snap-in socket type for edge lighting mounts to a circular cut-out in the back of dial or panel by means of a U-shaped bracket with prong projections. A single lead wire is employed and the equipment chassis serves as the ground. Stamped lamp receptacle and bracket are joined in a spot-welded construction; receptacles are available separately for mounting to other types of brackets to meet special requirements. Spring-action of bracket simplifies removal and replacement of socket for lamp changes.

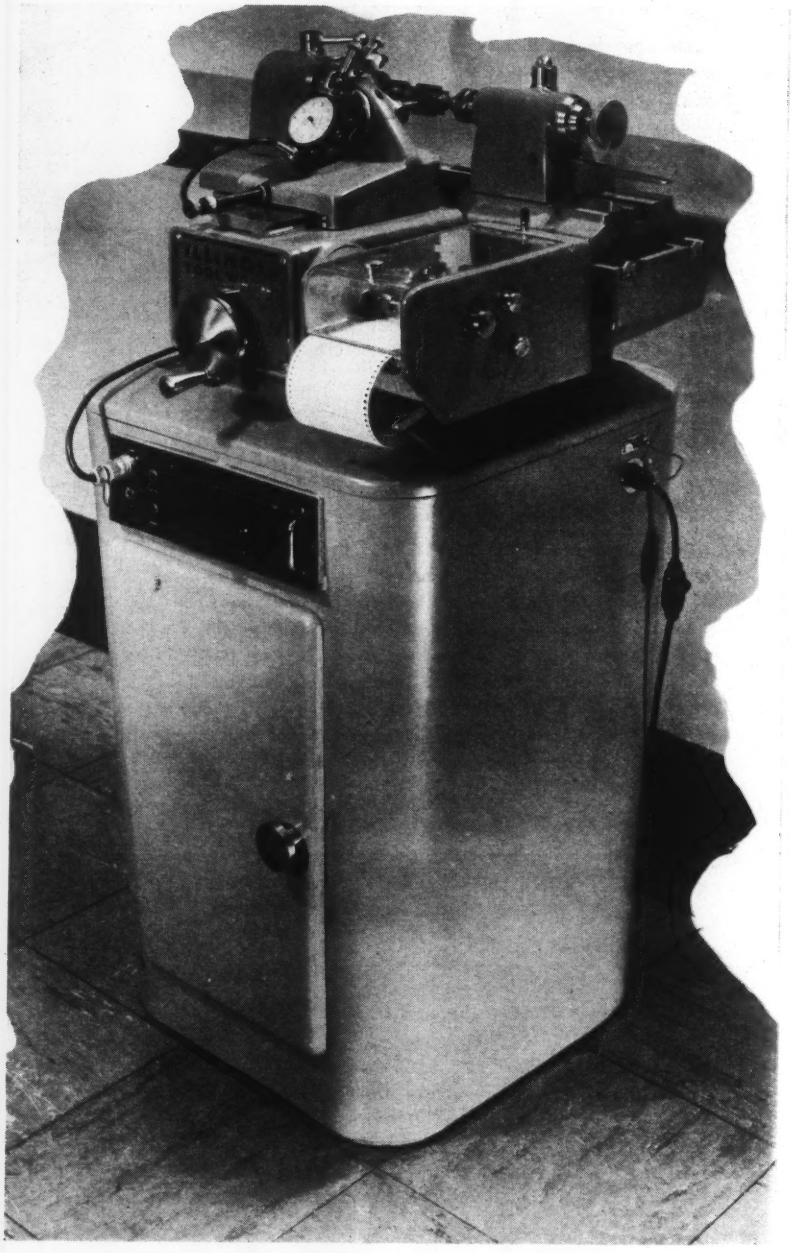




Insulated snap-in type has U-shaped bracket clamped to molded phenolic socket. As in the basic snap-in type, mounting is accomplished by means of a circular panel or dial cut-out. Two leads are provided for ac or dc operation without chassis grounding. Insulated sockets are also available separately for special applications.

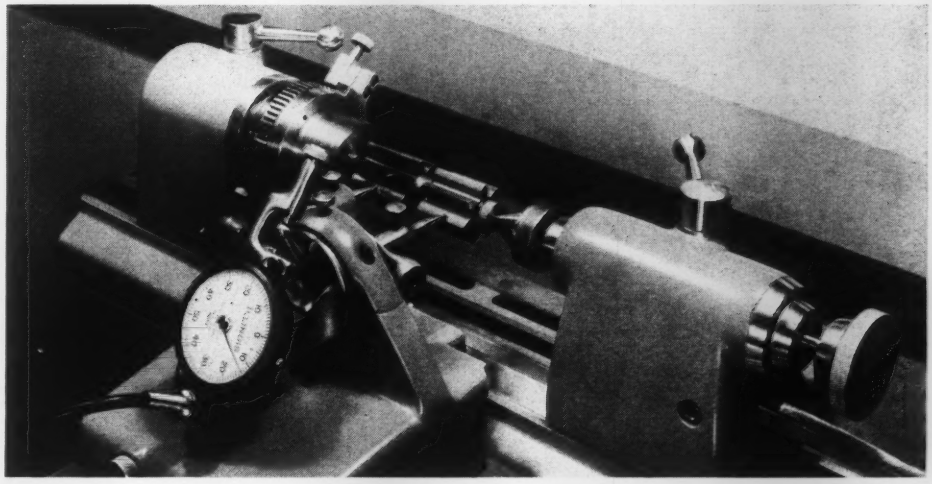


Simplicity Emphasized in Styling of Gear Comparator

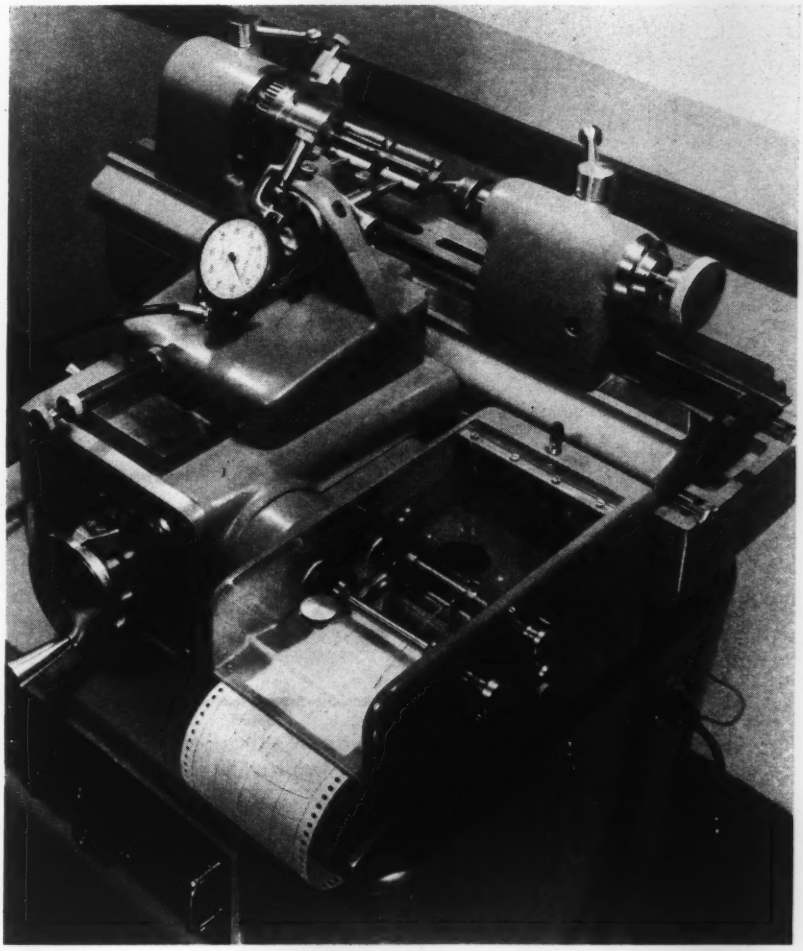


STYLED to emphasize simplicity of form and designed for ease of operation and maintenance, the new Analytical Comparator of Illinois Tool Works provides a quicker method of gear analysis than that provided by a complete analytical check with separate involute, space and helical lead checking machines. Appearance and styling have been developed by Reinecke and Assoc., working with Illinois Tool engineers, to provide a compact unit with "quality" character and easy-to-use controls.

Sheet-steel base of the machine is tapered to allow foot space while working. The nameplate, with aluminum lettering on a red background, provides a color accent which contrasts with the green-gray enamel used for the rest of the machine. A tray is incorporated on the top of the base to hold small tools while calibrations are being made, and the base contains a large storage space. With overall height of 46 inches, the Comparator is designed so that the working area is at a comfortable level for an average-height man.



Simple contours are used for the top castings, head stock and tail stock. The gage, which registers differences between the production gear and a master, contains large, easy-to-read calibrations. Table motion parallel to the gear axis checks the lead; perpendicular motion, the involute or tooth profile; and in-and-out motion of the indicator slide, the spacing. Thus, all essential gear checks are combined.



Electronic recorder provides a graphic record of the condition of the inspected surface and shows where errors actually originate. Control knobs, which are designed with slightly conical top surfaces to pick up highlights, are placed for ease of operation. All electronic equipment is located in an easily removed drawer type unit with controls at the front of the machine.

PRODUCTION AND DESIGN

Modern Practices in Manufacture

ALUMINUM Cold Forgings

With aluminum currently being used for designed parts at a volume rate second only to steel, newer processes for precision cold forging of aluminum are rapidly gaining attention. Developed essentially for high-volume production, the methods discussed here suggest many design possibilities for simplification and cost reduction

Fig. 1—Caps and cans impact extruded from 2S aluminum

By R. A. Quadt
Director of Research and Development
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Riverside, Calif.

DEVELOPMENTS over the last few years in the precision cold forging of strong aluminum alloys have opened additional avenues for design ingenuity; many shapes in the toughest alloys are being specified in routine fashion by engineers familiar with the existence of the newer processes.

Most engineers are acquainted with the impact extrusion technique for producing cans and hollow shapes from commercially pure aluminum (2S). Collapsible tubes for toothpaste represent a large outlet for such shapes, and *Fig.* 1 pictures a series of caps and cans extruded from 2S but left in the as-extruded condition to give the required stiffness and hardness. Yield strengths in the 15,000 to 20,000 psi range can be expected—adequate for many nonstructural applications.

At Hunter Douglas the emphasis has been on development of the process to permit high-speed production of parts from the strong aircraft type

Table 1—Specification Mechanical Properties of Aluminum Impact Forgings

Alloy	Tensile Strength (1000 psi, min)	Yield Strength (1000 psi, min)	Elongation (% in 2 in., min) Test Coupon	Elongation (% in 2 in., min) Forging
61S-T6	38	35	10	7
A51S-T6	44	37	14	10
14S-T6	65	55	10	7
75S-T6	75	65	10	7
HD-11-T6*	50	42	10	7
HD-11*	37	32	5	3

*Hunter Douglas alloy.

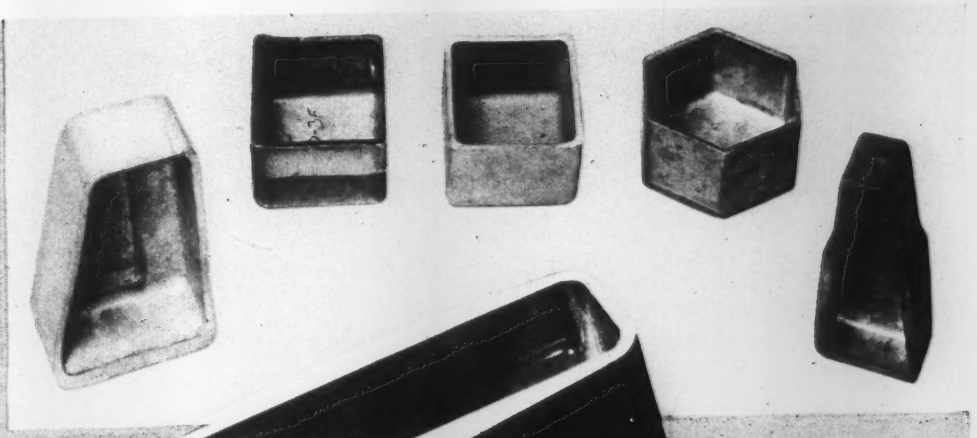


Fig. 2—Cans cold forged from 14S-T6 aluminum for airframe applications

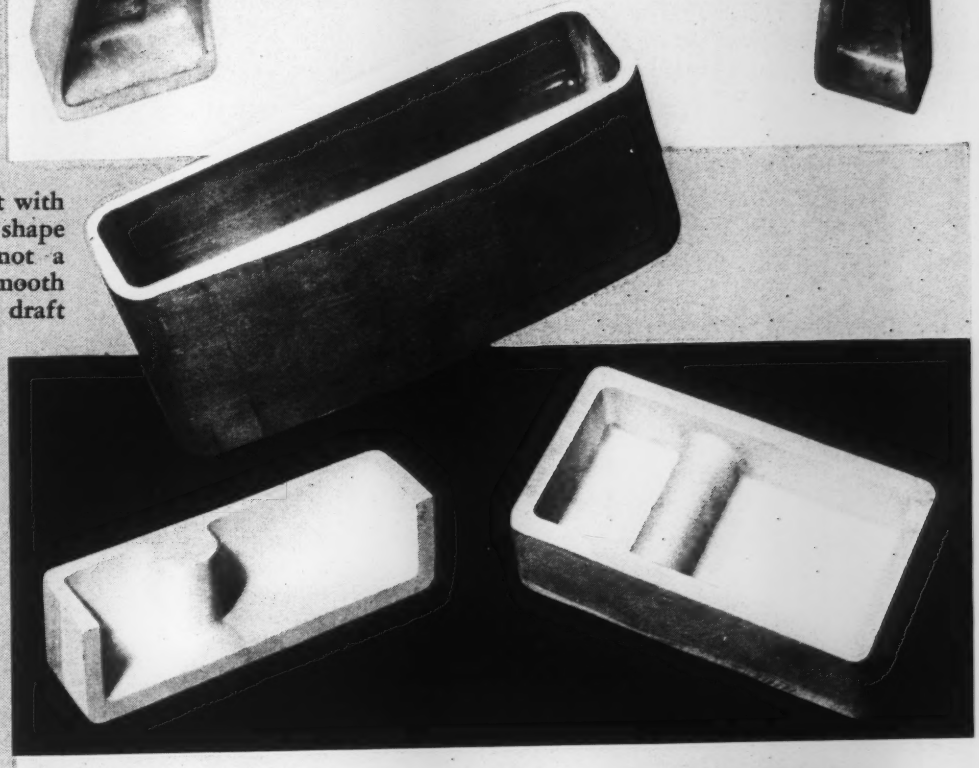


Fig. 3—A 14S-T6 part with unequal walls; inside shape is a parallelogram, not a rectangle. Note smooth wall finishes and zero draft

Fig. 4 — Rectangular can of 14S-T6 with off-center rib

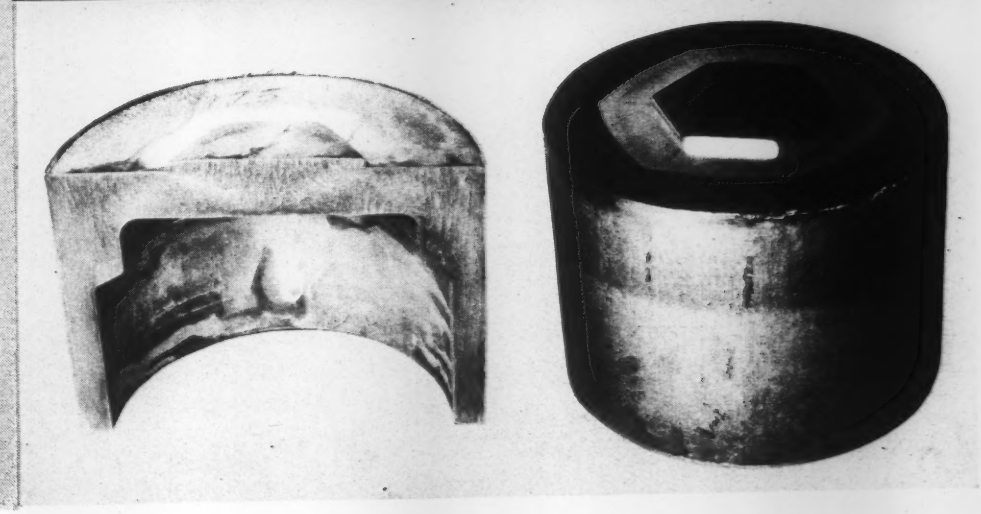


Fig. 5—Flow lines in etched cross section of 14S-T6 cap. Forged hex is for assembly purposes

alloys. That this emphasis was justified is borne out by the fact that monthly production of strong alloy cold forgings, mostly heat treated, has consistently exceeded production requirements for impact extrusions from soft alloys like 2S. Parts have been cold forged by the millions at rates up to 2000 per hour.

Alloys and Properties: A wide range of mechanical properties is available. The lowest yield-strength material that will satisfy stress requirements should be specified since cost rises generally with the strength specified. Traditionally, aluminum forgings have been heat-treated for stressed applications, but strengths in the cold-forged temper are often adequate, and savings resulting by eliminating heat treatment are substantial when large quantities of parts are needed. As shown in *Table* 1, yield strengths approximating hot-finished mild steel can be had in HD-11 alloy in the cold-forged condition. Should higher properties be needed, this composition is also heat treatable, and the com-

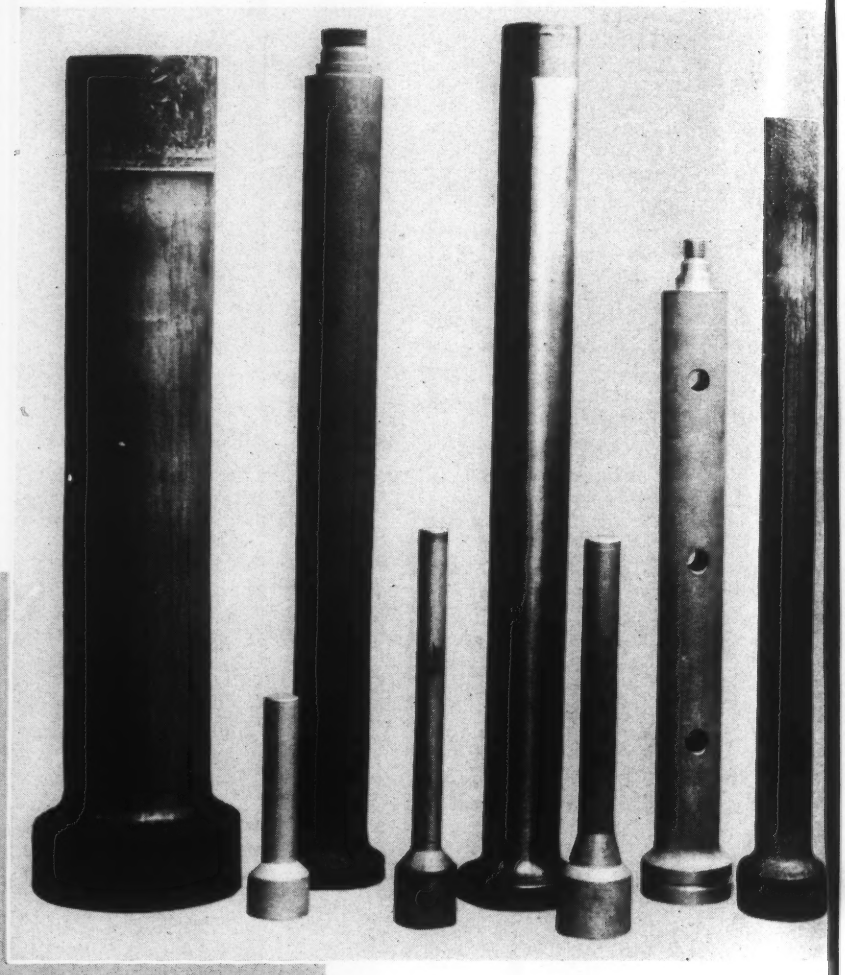


Fig. 6—Family of flanged tubes, with opposite end closed, from alloys 14S-T6 and HD-11; lack of draft and smooth surfaces from forging die are features. Large tubes second and fourth from left are subsequently machined

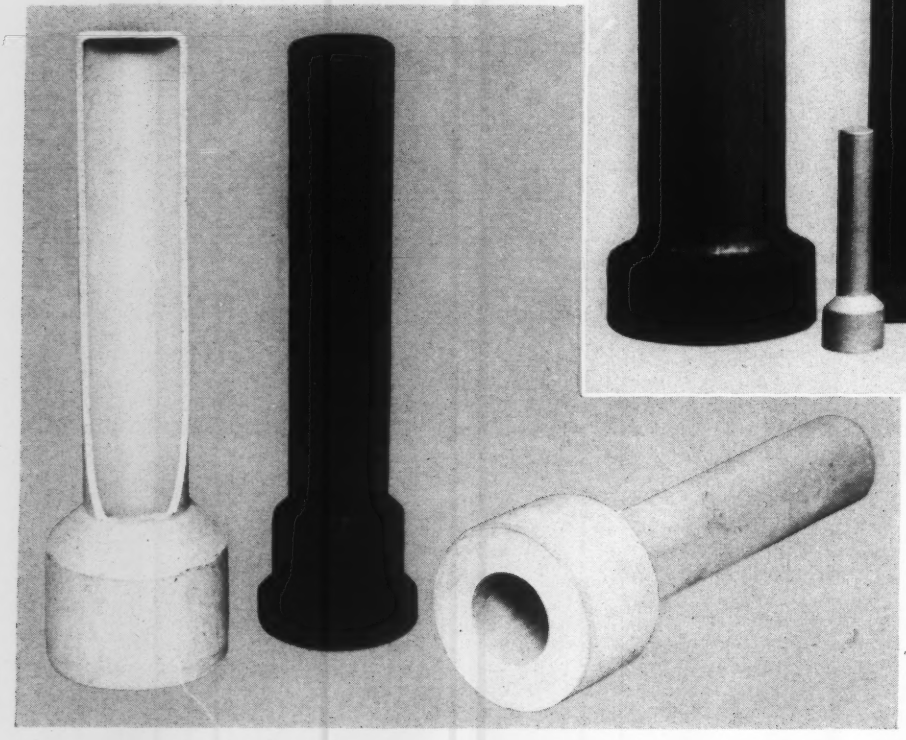


Fig. 7—Additional views of the smallest part in *Fig.* 6 showing thin walls and base. Center piece is black anodized

mercial heat-treated forging alloys may be specified if required.

Strong-Alloy Cans: *Figs.* 2, 3 and 4 show various closed-bottom shapes produced from 14S-T6 and 75S-T6 alloys. Most of these are used in airframes as brackets, attachment fittings and stiffeners. All are stressed parts requiring the strengths specified for these alloys. Since nearly all walls are made with zero draft, no excess material need be machined away. Parts can be used directly by cutting to length and drilling the necessary rivet holes.

One of the reasons for specifying the cold forging process concerns the continuous flow lines developed during fabrication. These fibers connect the base with the side walls in an unbroken pattern, *Fig.* 5. Increased fatigue properties are obtained and bending stresses at the inside corners are distributed parallel to the flow lines rather than cross grain as would be the case if the part were machined from rolled or forged bar.

Closed-End Tubes: A range of closed-end tubes produced by cold forging the strong alloys 14S-T6 and HD-11 is shown in *Figs.* 6 and 7. Walls contain no draft, and diameter tolerances are typically $\pm$0.005-inch, although a tolerance of $\pm$0.008-inch would be desirable for thick-walled tubes over 20 inches long. Similar closed-end tubes up to 35 inches long have been forged, and there is no indication that the ultimate length is being approached. Closed-end tubes up to 5 or 6 feet long are quite feasible if there were a commercial need for them. Tubes can be made with or without the flanges shown in the photographs, walls can vary

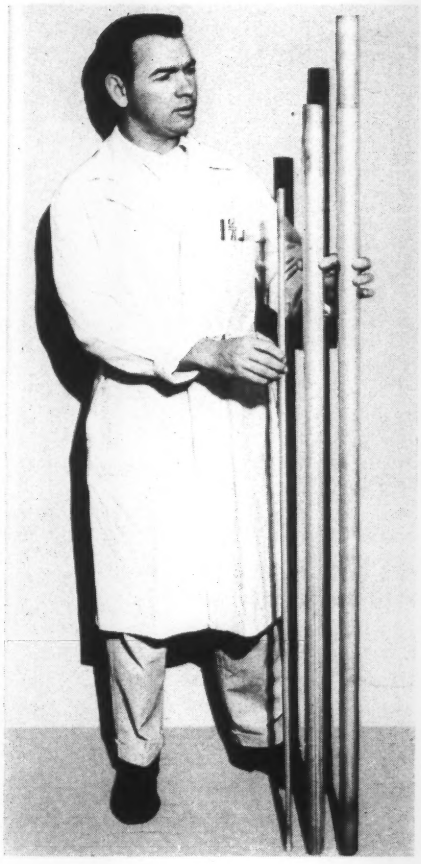


Fig. 8—Experimental tubes with original lengths over 5 feet. Walls are from 0.014-inch to 0.035-inch; alloys 14S and HD-11 are used

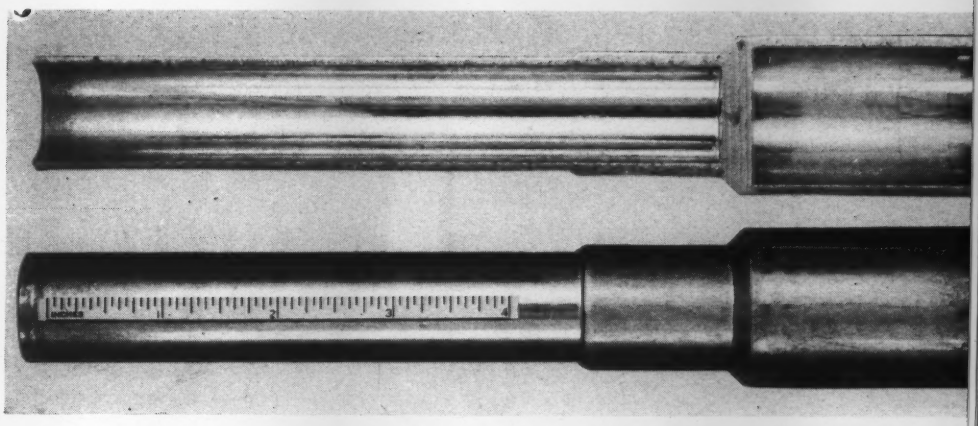
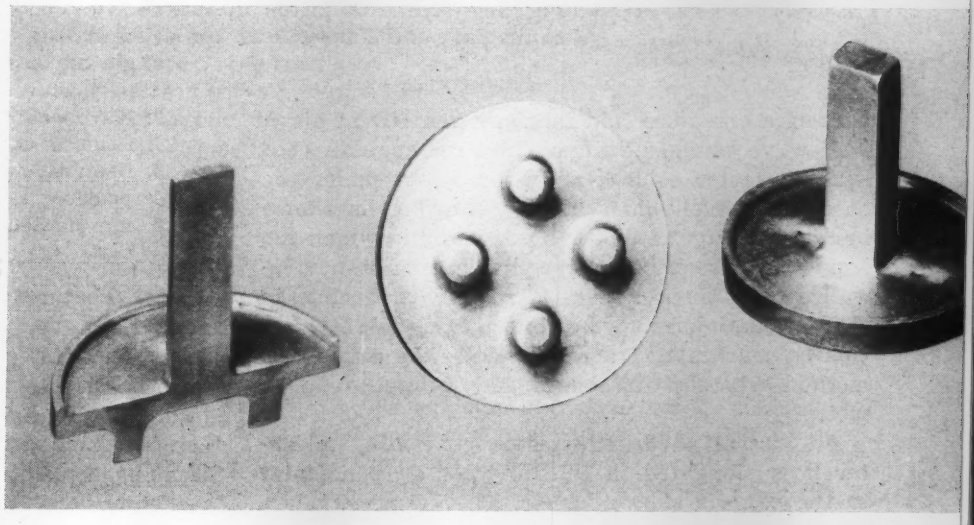


Fig. 9—Above—One-piece webbed tube of varying diameters from alloy HD-11

Fig. 10—Below—Cold-forged valve plunger of A51S-T6 alloy

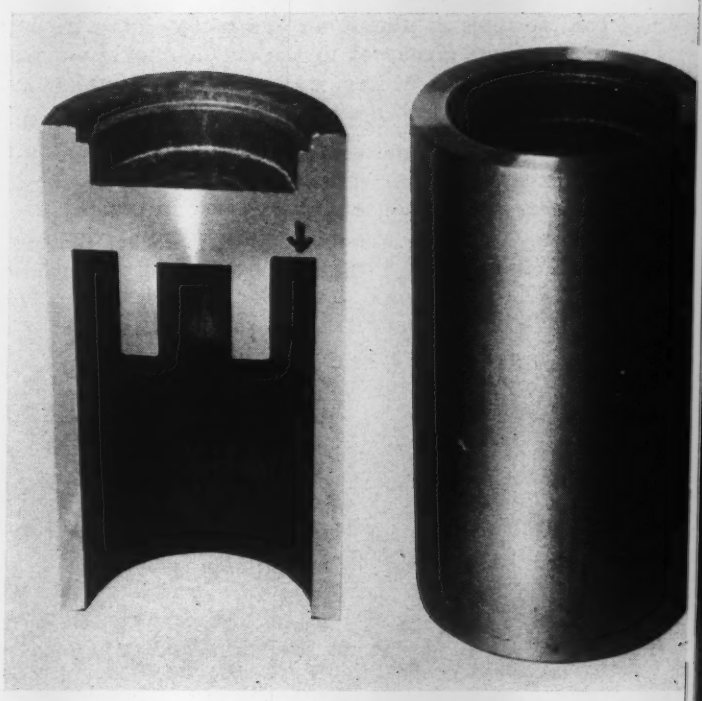


from 0.050-inch to ½-inch or thicker, and bases can be made any required thickness.

Open-End Tubes: The cold-forging process also has found a place in the fabrication of precision tubing. Wall tolerances of ±0.002-inch are readily held and the properties of the as-forged tubing are adequate for many applications. *Fig.* 8 shows some strong alloy tubes produced at Hunter Douglas. Lengths over 6 feet are practical with walls varying from 0.015-inch to ¼-inch and over, although the chief advantages lie in fabrication of thin walls of 0.030 to 0.100-inch where close wall tolerances, straightness, smooth finish, and high strengths are required.

Miscellaneous Shapes: Design requirements dictate many shapes ideally suited to cold forging. *Fig.* 9 shows a part forged by flowing metal in both directions leaving a separating web beween the cylinders. This one part contains two inside diameters and three outside diameters. It is made from a solid slug in one press operation. An unusual feature is the close tolerance (±0.001 inch) specified for the ID of the tube. This part was originally designed as a three-piece assembly. Important cost reduction was possible by making this

Fig. 11 — Housing of HD-11 alloy showing double-wall feature in base



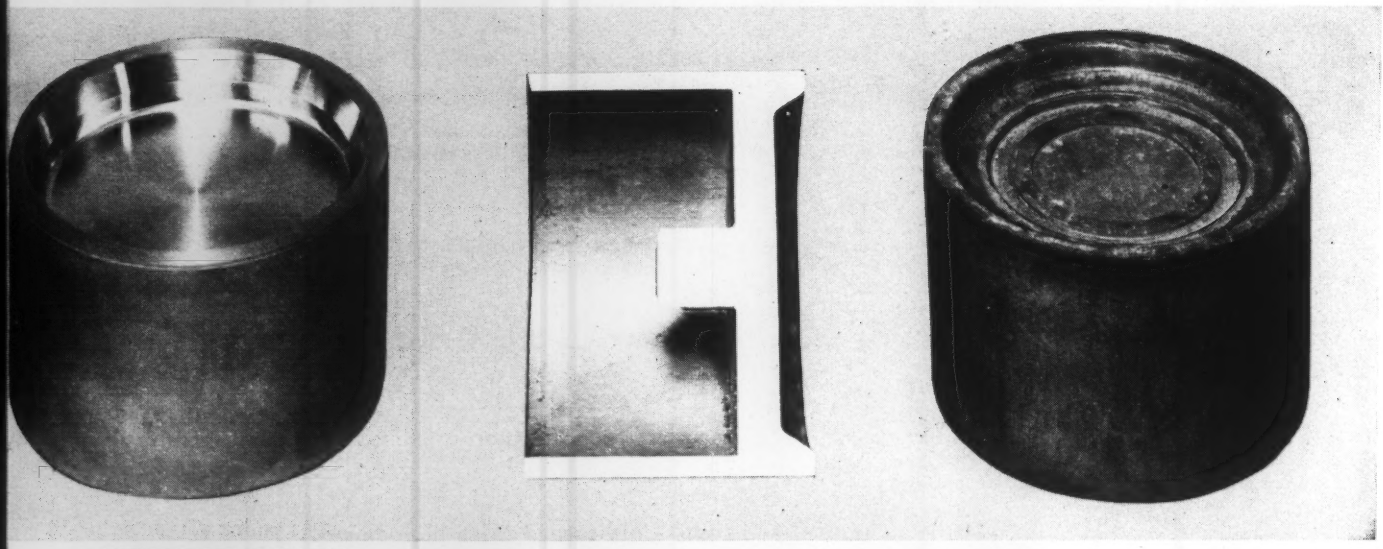


Fig. 12—Hydraulic piston in 14S-T6 alloy. Center boss is elongated perpendicular to the page and is three times the width shown. Note zero inside draft and 30-degree angle on base

part as a one-piece cold forging from HD-11 alloy.

A valve plunger with a solid rectangular (not square) center column and four bosses under the base into which blind holes are drilled is shown in *Fig.* 10. *Fig.* 11 pictures a housing in which the inside base required the equivalent of a double-walled can. Such a part is readily producible in strong aluminum alloys at lower cost than fabrication by machining from bar stock—the only other method whereby tolerances and strength can be met.

An aircraft hydraulic piston containing a center boss elongated in the direction perpendicular to the page is shown in *Fig.* 12. Valve ports are machined through the boss as required. *Fig.* 13 shows a flanged attachment bracket press forged complete except for the drilled holes.

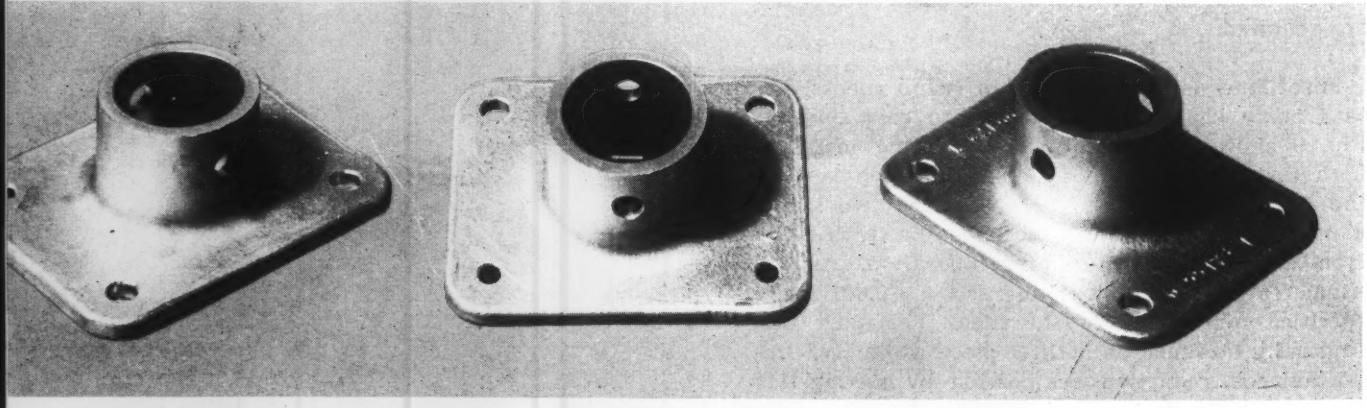
Designing Cold Forgings: Shapes amenable to cold forging in aluminum are many, but a review of the parts discussed in the article should suggest a number of features, one or more of which are common to every design. In general, parts

1. Are generally symmetrical
2. Have hollow sections
3. Have walls or surfaces requiring zero draft
4. Require the strength of forgings
5. Require close tolerances to eliminate expensive machining operations
6. Are needed in large quantities at low unit cost.

Cost Features: The new process is inherently geared to very high production requirements. Monthly quotas of 1000 to 10,000 units would barely be sufficient, while 100,000 to 1,000,000 most certainly would. Applicable shapes in these quantities can often compete costwise with castings, and for large parts that are turned from bar stock on screw machines, cost of the finished cold forging may be less than the aluminum bar alone from which the part is machined. Experience has also shown that many cast-iron and steel parts requiring numerous close-tolerance machining operations can be produced at lower cost as aluminum cold forgings if required quantities are high.

On the other hand, smaller quantities not in the "high production" category are often specified and manufactured as cold forgings because of the influence of other advantages to the designer. Each part must ultimately be judged on its own merits.

Fig. 13—Attachment bracket of A51S-T6. Tube section with zero draft walls can be produced in any nominal length



Predicting Minimum-Inertia

POWER GEAR TRAINS

Charts based on realistic gear proportions provide advance information for design of minimum-inertia trains for control systems

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DESIGNERS of precision gear trains for high-performance servomechanisms are often required to minimize the rotational inertia added by the reduction gearing to that unavoidably introduced by the control motor and the driven load. The influence of inertia of moving parts on their speed of response is a subject as old as Newtonian mechanics; its critical effect on the stability of closed-loop control systems belongs to the relatively newer field of servomechanisms. To the designer, the terms "minimum" or "optimum" portend time-consuming trial-and-error processes unless definitive answers to the following questions are obtained:

1. What are the defining equations?
2. What are the significant parameters or factors?
3. Does a minimum or maximum exist with respect to any or all parameters?
4. Are the optimum parameter values explicitly obtainable?

In original design, no set of equations can apply precisely to all situations; the designer must therefore study the theoretical conditions in relation to his practical problems and, given the order of magnitude of the results and the relative influence of the various parameters, proceed to a specific trial-and-error solution from a vantage point within sight of the goal.

In this article the theoretical bases for minimum-inertia power gearing design will be developed in a form of direct and practical utility in design. Equations and curves presented will be found useful in the following ways:

1. To estimate an optimum number of gear meshes and their ratios to obtain a certain overall reduction in a power train.
2. To estimate the penalty in increased inertia for using nonoptimum ratios or fewer meshes.
3. To estimate minimum obtainable gearing inertia and determine its significance.
4. To adjust overall reduction to obtain maximum frequency response including the effect of gearing inertia.

Design Basis: A number of bases have been proposed and practiced for determining proper gear ratios in a speed-reducing chain to present a minimum of reflected inertia to the drive-motor shaft.

One of them, for example, assumes that all pinions are identical; therefore it is applicable only to gear trains of an instrument or breadboard type, where minimum pitch is used throughout or where setups are constructed of standard parts. Formulas in this case, however, lead to power gear trains having far from optimum results.

In a gear train used for power transmission, or where full torque of the drive motor must be developed by each gear mesh because of loads or limit stops, the basic size of gears must increase as the speed is reduced. A valid assumption for this case is that the number of teeth in each pinion is a constant, for this is a minimum depending not upon pitch but upon pressure angle and tooth profile system.

The method by which circular pitch and face width increase as speed is reduced is dependent on the many factors of materials, service, environment, and load. Two basic formulas are of importance: the Lewis formula for beam strength and the Buckingham wear load formula. With broad

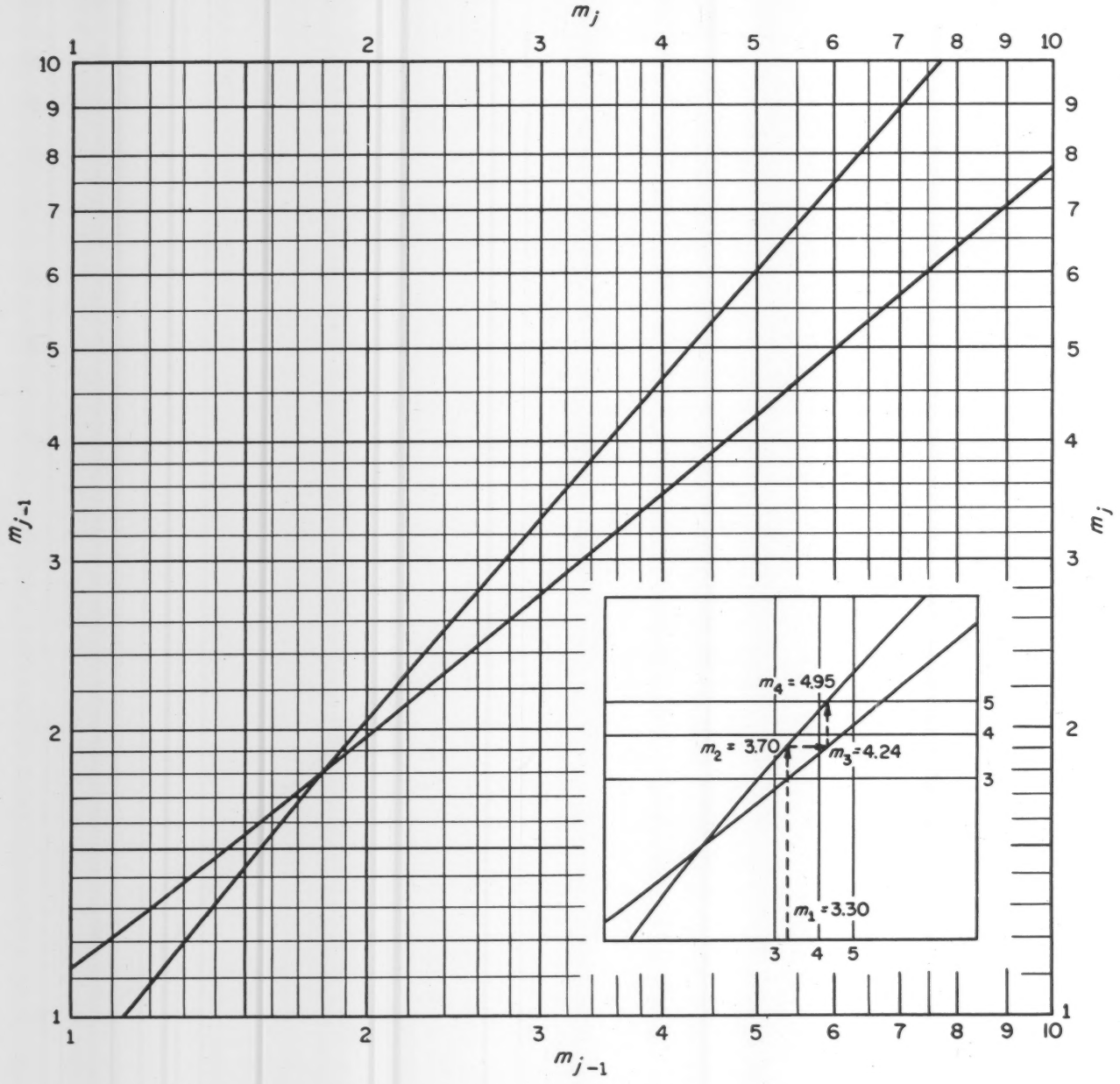


Fig. 1—Optimum-ratio recursion curves. Inset example shows how curves are used to find optimum ratios in a four-mesh system for gear reduction ratio $m = 256$. First ratio m_1 is determined from *Fig.* 2

assumptions, (see *Appendix*), both formulas reduce to the following useful "first approximation" relationship:

$$FD_P^2 = Km \quad \ldots\ldots (1)$$

where

D_P = Pitch diameter of driving pinion
F = Face width of meshing gears
K = Proportionality constant
m = Reduction ratio from motor to given pinion

The sizes of shafts, bearings, etc., are assumed proportional to, and are therefore lumped with, the moments of inertia of gears.

A reasonable and simple system for determining face width and pinion pitch diameter at any mesh (see *Appendix*) is to choose:

$$\frac{F}{F_0} = \frac{D_P}{D_{P0}} = \frac{P_0}{P} = m^{1/3} \quad \ldots\ldots (2)$$

where P = diametral pitch and subscript 0 refers to the motor pinion.

Minimum Inertia: The inertia J_P of a pinion, taken as a disk, is proportional to its density, its width F and the fourth power of its diameter D_P. If it is a part of a reducing mesh m_1, the

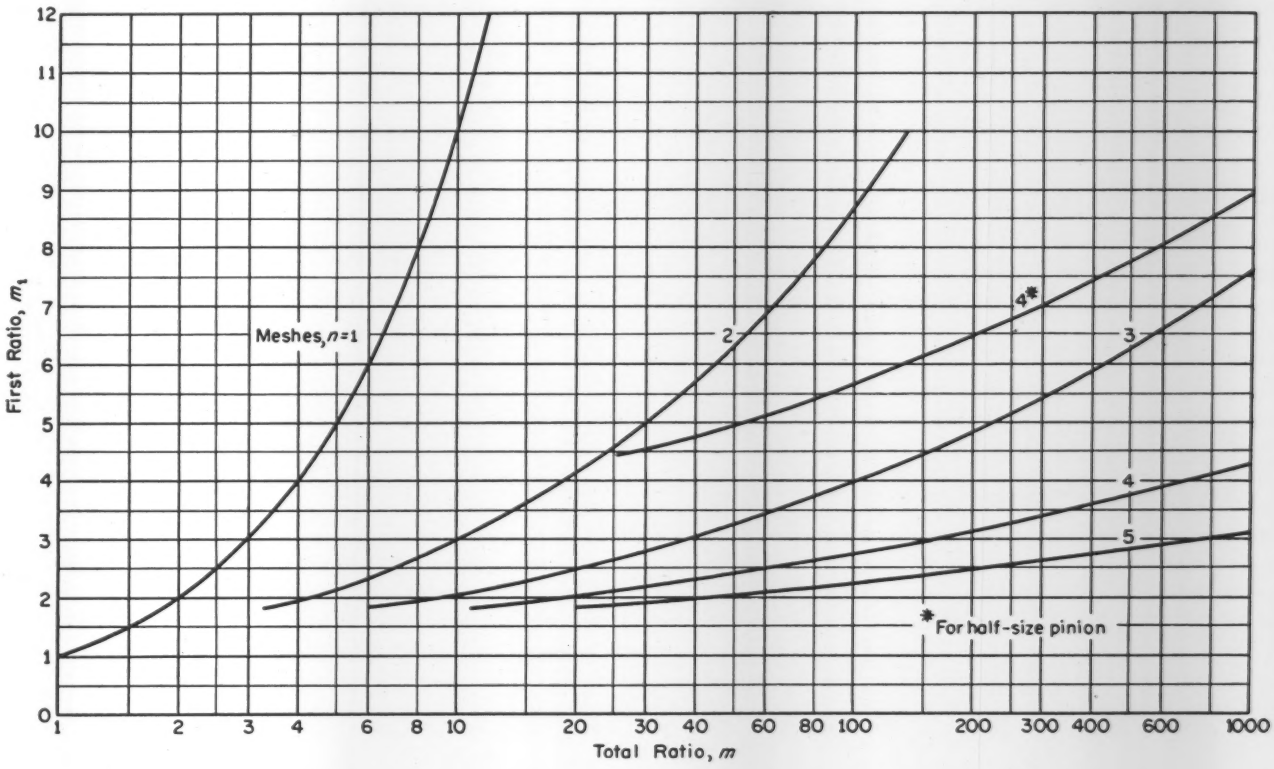


Fig. 2—First ratio m_1 versus total ratio m for different numbers of meshes n

driven gear diameter is $m_1 D_{P0}$ and its inertia is $m_1^4 J_{P0}$. Reflected at the driving shaft, the driven inertia is $m_1^2 J_{P0}$, and the total of the mesh is

$$J_1 = J_{P0}\ (1 + m_1^2) \quad \ldots\ldots (3)$$

If now on the second shaft another pinion drives another gear, the second mesh inertia referred to the second shaft is $J_{P1}\ (1 + m_2^2)$. But from Equation 2,

$$J_{P1} = J_{P0}\ m_1^{1/3}\ (m_1^{1/3})^4 = J_{P0}\ m_1^{5/3} \quad \ldots\ldots (4)$$

Reflected to the first shaft, the second mesh inertia is

$$J_{P0}\ \frac{m_1^{5/3}}{m_1^2}\ (1 + m_2^2) = J_{P0}\ m_1^{-1/3}\ (1 + m_2^2)$$

The total two-mesh inertia is then

$$J_2 = J_{P0}\ [(1 + m_1^2) + m_1^{-1/3}\ (1 + m_2^2)] \quad \ldots\ldots (5)$$

Similarly, for any number of meshes,

$$J_n = J_{P0}[(1 + m_1^2) + m_1^{-1/3}\ (1 + m_2^2) + (m_1 m_2)^{-1/3}\ (1 + m_3^2) + \ldots + (m_1 \ldots m_{j-1})^{-1/3}\ (1 + m_j^2) + \ldots + (m_1 \ldots m_{n-1})^{-1/3}\ (1 + m_n^2)] \quad \ldots\ldots (6)$$

For minimum inertia, the partial derivatives of J_n with respect to any ratio m_j must be zero. This process leads to

$$m_j^2 = \frac{6}{7}\ [(m_{j-1})^{7/3} + 1] - 1 \quad \ldots\ldots (7)$$

This is a recursion formula for minimum inertia and is plotted as *Fig.* 1. For any ratio m_j one can find the corresponding optimum next upper or lower mesh. The curve is plotted twice so that one may determine all the ratios in a train by "zig-zagging" between the two curves, as illustrated in the example shown with *Fig.* 1.

It can be seen that the curves cross at a value $m_j = 1.82 = m_{j-1}$. Thus an optimum gear train may be designed in which every mesh reduces by 1.82. Moreover, in any train, the ratios toward the driving end approach 1.82 as the number of (optimum) meshes increases, no matter whether the lowest speed ratio is greater or less than that value. The ratio 1.82 also determines the transition points to greater or fewer meshes. If

$$1.82^{n-1/2} < m < 1.82^{n+1/2}$$

then n meshes should be used in the train for minimum inertia.

The total inertia can be developed by use of the recursion formula, Equation 7:

$$J_n = [(1 + m_1^2) + m_1^{-1/3}\ (1 + m_2^2) + \ldots + (m_1 \ldots m_{n-1})^{-1/3}\ (1 + m_n^2)]\ J_{P0} \quad \ldots\ldots (8)$$

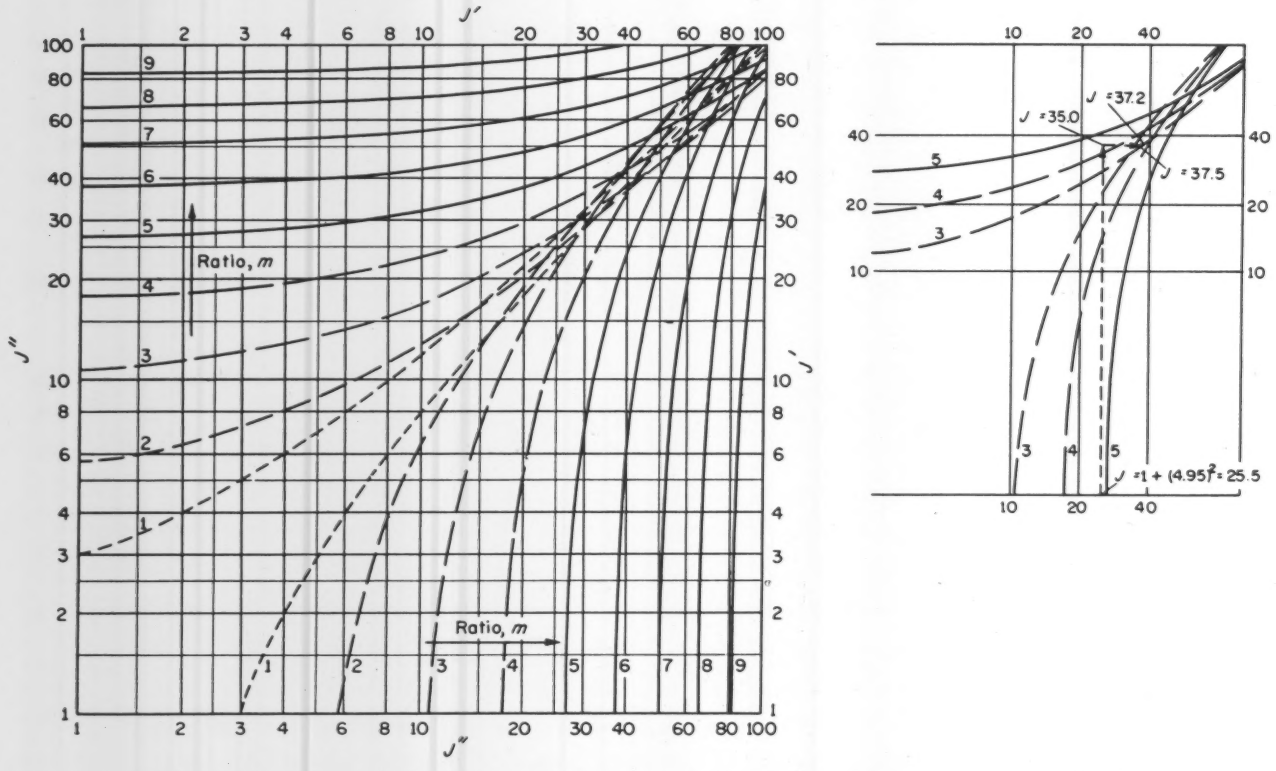


Fig. 3—Inertia recursion curves. Inset example shows how curves are used to find inertia factors of optimum four-mesh train with total ratio $m = 256$. Individual mesh ratios from *Fig.* 1 are (3.30) (3.70) (4.24) (4.95)

$$\frac{J_n}{J_{P0}} = 1 + m_1^2 + \frac{6}{7} m_1^2 + \left(\frac{6}{7}\right)^2 m_1^2 + \ldots \quad (9)$$

This process can be continued, and as n approaches infinity,

$$\lim_{n\to\infty} \left[\frac{J_n}{J_{P0}}\right] = 1 + m_1^2 + m_1^2 \sum_{n=1}^{\infty} \left(\frac{6}{7}\right)^n$$

$$= 1 + m_1^2 + 6\, m_1^2$$

$$= 1 + 7\, m_1^2 \quad \ldots\ldots (10)$$

But it has already been shown that as number of meshes n approaches infinity the first ratio m_1 approaches 1.82. Therefore, an infinite reduction can be obtained with the inertia ratio

$$\left[\frac{J_n}{J_{P0}}\right]_{n=\infty} = 1 + 7\ (1.82)^2 = 24.2$$

A corollary is that any finite reduction may be obtained with an inertia ratio less than 24.2 if each individual ratio is made equal to 1.82.

First Mesh Ratio: The ratio recursion curves were used in the following manner to obtain curves of first mesh ratio m_1 for a given overall ratio m, to be obtained in n meshes: A value m_1 or m_n was chosen; n steps were taken on the recursion curves, *Fig.* 1, and each m_j was recorded. The n values of m_j were multiplied together to yield m, and m_1 was plotted against m, *Fig.* 2.

The n values of m_j may also be substituted into inertia Equation 6 to calculate values of inertia factor J_n/J_{P0} for each m. However, it is simpler to use the inertia recursion curves, *Fig.* 3, which are simply plots of the inertia transfer function (Equation 5)

$$J'' = 1 + m^2 + m^{-1/3}\, J' \quad \ldots\ldots (11)$$

for various parameters m. These curves are also plotted twice so that the same zig-zag procedure may be employed, as illustrated also in *Fig.* 3. By this means the total gear train inertia factor (the ratio of total to driving pinion inertia) was plotted against m for various values of n, *Fig.* 4.

The minimum inertia curves, *Fig.* 4, may be used to determine the minimum possible gearing inertia, the optimum number of meshes, and the penalty for using fewer meshes. It may also by used as a standard of comparison for evaluating nonoptimum gear trains. For instance, consider an overall reduction of 256, which may be obtained in four optimum meshes with an inertia factor of 37.2. Suppose instead four meshes of 4/1 each are used. The inertia recursion curves show a factor here of

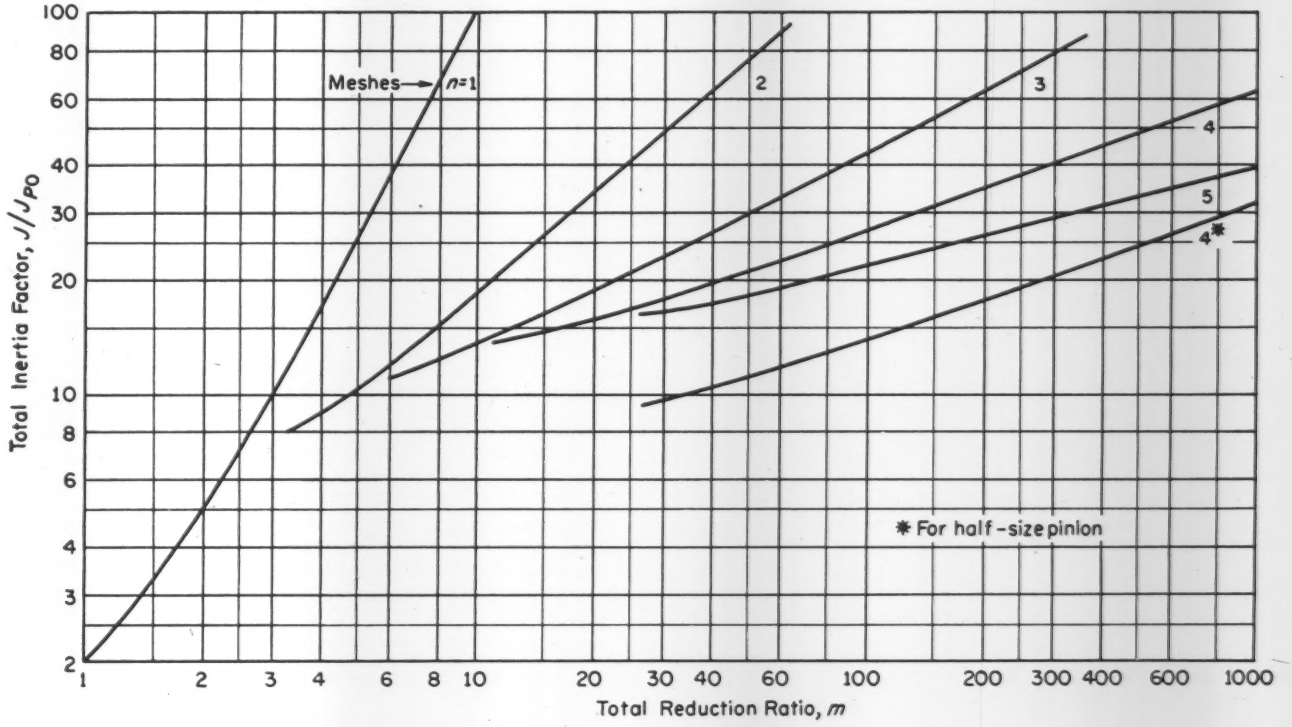


Fig. 4—Minimum-inertia curves in terms of total inertia factor J/J_{P0}, total ratio m, and number of meshes n

38.8, an almost negligible increase. Suppose, however, ratios are chosen from formulas which ignore the increase in face width and pinion diameter. In this case the ratios are (1.87) (2.50) (4.33) (12.65) and the inertia factor is 81.4, more than double the optimum value.

Fewer Pinion Teeth: Some servo motors are available with pinions cut into their shafts, or the first pinion may be mounted cantilever; a special analysis is required to take advantage of this provision. Suppose that the motor pinion has half the number of teeth as the others in the train. For the same pitch, the diameter is thus halved. Since the tangential tooth load is doubled, the face width must also be doubled. Therefore the inertia (proportional to FD_P^4) is ⅛ that of the "standard" full-size first pinion. Total gear-train inertia factor is then

$$\frac{J_n'}{J_{P0}} = \frac{1 + m_1^2}{8} + m_1^{-1/3}\left\{ (1 + m_2^2) + m_2^{-1/3}\,(1 + m_3^2) + \ldots \right\} \quad \ldots\ldots (12)$$

where J_n' = total inertia of train with half-size motor pinion. By following the same procedure as for the normal case, a transfer formula between m_1 and m_2 is obtained:

$$m_2^2 = \frac{\frac{3\,m_1^{7/3}}{4} - 1}{7} \quad \ldots\ldots (13)$$

Equation 13 is plotted as *Fig.* 5. Optimum first ratios in four mesh trains for this special case were obtained for the half-size motor pinion curve in *Fig.* 2 by selecting optimum first ratios for various three-mesh trains and entering these values as m_2 in *Fig.* 5. Factor m_1 thus obtained was the new first ratio and the multiplier for a new overall ratio.

The inertia for each three-mesh train selected was entered as the parenthetical term in Equation 12 for total inertia factor, together with the appropriate functions of m_1. The resulting value was plotted against new overall ratio as the half-size motor pinion curve in *Fig.* 4.

It is noted that, when it is possible to reduce to half the number of teeth in the first pinion, overall inertia is about halved while the optimum first ratio is approximately doubled. For an infinite reduction,

$$\lim_{n\to\infty}\left[\frac{J_n'}{J_{P0}}\right] = \frac{1 + m_1^2}{8} + m_1^{-1/3}\,[1 + 7\,m_2^2] = \frac{1 + 7\,m_1^2}{8} \quad \ldots\ldots (14)$$

For $m_2 = 1.82$, $m_1 = 4.43$ (from *Fig.* 5), and

$$\left[\frac{J_n'}{J_{P0}}\right]_{n=\infty} = 17.25$$

This result compares with 24.2 in the normal case.

Other Criteria: The preceding formulas and curves are useful where the desired overall gear ratio is known—that is, fixed by considerations of velocity, torque, or computation. Where gain or torque is limited and either a maximum frequency response or maximum load acceleration is desired (assuming velocity and static torque specifications are adequately met), the choice of overall gear reduction is a critical factor. If the gear inertia is negligible, the familiar relationship

$$J_L = m^2 J_M \quad \ldots\ldots (15)$$

leads to maximum load acceleration for a given motor torque. For gears with finite inertia, the choice of m is somewhat different. Let

J_L = Load inertia
J_M = Motor inertia
J_P = Motor pinion inertia
J_T = Total inertia at motor shaft
K = Gear inertia factor
m = Gear reduction
T = Motor torque
α_L = Load acceleration
α_M = Motor acceleration

Then:

$$\alpha_L = \frac{\alpha_M}{m} = \frac{T}{m J_T} \quad \ldots\ldots (16)$$

and

$$J_T = J_M + \frac{J_L}{m^2} + KJ_P \quad \ldots\ldots (17)$$

For α_L = maximum, mJ_T = minimum. From Equation 17,

$$mJ_T = mJ_M + \frac{J_L}{m} + mKJ_P \quad \ldots\ldots (18)$$

Then

$$\frac{\partial (mJ_T)}{\partial m} = J_M - \frac{J_L}{m^2} + J_P \frac{\partial}{\partial m} (Km) = 0 \quad \ldots (19)$$

since $K = f_K(m)$. Finally

$$\frac{J_L}{J_M} = m^2 \left[1 + \frac{J_P}{J_M} \frac{\partial}{\partial m} (Km) \right] \quad \ldots\ldots (20)$$

It is seen here that m will be less than that for negligible gear inertia, Equation 15. The latter value may be chosen as a first trial and $J_T m$ plotted against decreasing values of m; or an approximation of the function f_K may be made for a close one-step solution. For example, for $n = 5$ meshes, f_K is approximately $7m^{1/4}$. Suppose $J_L/J_M = 10^6$, $n = 5$, and $J_P/J_M = 0.01$. Then

$$\frac{\partial}{\partial m} (Km) = 7 \left(\frac{5}{4} \right) m^{1/4}$$

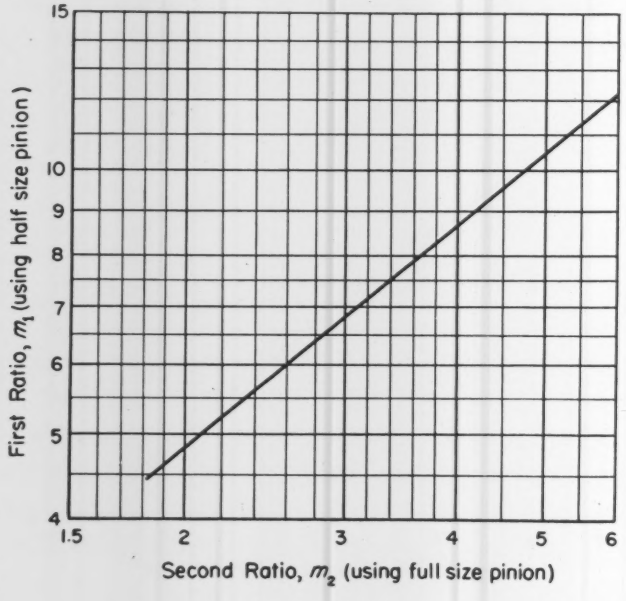
From Equation 20

$$10^6 = m^2 \left(1 + \frac{0.35}{4} m^{1/4} \right)$$

$$m = 810$$

If gear inertia were considered negligible, m = 1000 from Equation 15.

Fig. 5—Optimum transfer curve—half-size to full-size pinion



Conclusions: It should be borne in mind that the analysis is necessarily based upon a number of restrictive assumptions, which must be evaluated for each new design problem. However, it is believed that the relations chosen represent good engineering practice and that the results would change but little as applied to any well designed gearing.

It is worthy of note that there is a basic question to be asked before the design of a servo train is started: is it necessary to build for minimum inertia at all? The answer to this depends, of course, upon two factors: the required performance of the servo and the relationship of gearing inertia to that of motor and load. The data presented here will be of value in determining whether even grossly nonoptimum gearing is of any significance in the overall system.

Finally, there are other factors to be considered in gearing design for high-performance control systems. While considerations of minimum inertia call for a large number of low-ratio meshes, the factors of backlash, static friction, size, weight, and cost in general call for fewer gears, shafts, and bearings. The engineering task is to gather data on all these factors in order to produce an "optimum" design.

Appendix: Certain assumptions and procedures upon which the foregoing development is based are briefly justified and outlined in the following sections.

EQUATION 1: This basic equation is derived from the beam-strength relationship,

$$W = spFy$$

where W = tangential load, s = allowable stress, p = circular pitch, F = face width, and y = Lewis form factor. Let the following symbols also apply: D_P = pinion pitch diameter, N_P = number of pinion teeth, T_P = pinion torque, T_M = motor torque, and m = reduction ratio. Three relationships introduce these additional factors:

$$p = \frac{\pi D_P}{N_P}, \quad W = \frac{2}{D_P} T_P, \quad T_P = m T_M$$

From these equations and the beam strength equation,

$$FD_P^2 = \left[\frac{2 T_M N_P}{sy \pi} \right] m$$

For a constant minimum number of pinion teeth in all meshes, the same pressure angle, and the same material for all, the factors within brackets can be replaced by a constant, K, thus leading to Equation 1.

This same equation is also an approximation for the Buckingham wear load equation,

$$W = D_P F K_1 Q$$

where K_1 = factor involving elasticity, yield stress and pressure angle, Q = ratio factor $D_G/(D_P + D_G)$. Since, from foregoing equations, $W = 2mT_M/D_P$, one may rewrite the wear load equation in the form

$$FD_P^2 = \left[\frac{2 T_M}{K_1} \left(\frac{D_P}{D_G} + 1 \right) \right] m$$

Here, with the same materials throughout and fairly constant ratios from mesh to mesh, constant K may be substituted for the bracketed quantity and again the basic approximation of Equation 1 results. As earlier demonstrated, ratios in an optimum train tend to be of the same order of magnitude.

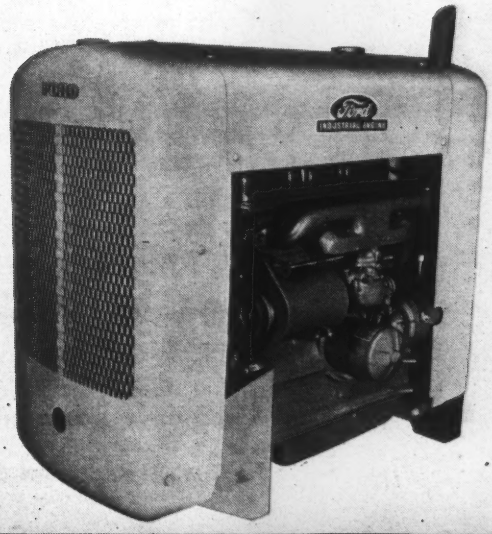
EQUATION 2: The foregoing developments are based upon the assumption that successive face widths and circular pitches shall be proportional to the cube root of mesh ratio. As limiting as this assumption might seem at first glance, it is based upon good practice. Its validity as a reasonable choice can be tested by comparing its results with those obtained on the basis of other criteria. As an example, let reduction $m = 1000$, and for the first pinion, diametral pitch $P_0 = 100$, pinion teeth $N_{P0} = 20$, face width $F_0 = 0.10$-inch. Then by three different methods:

Basic Assumptions	Last Pinion Data
1. Constant face width; diameters related by $D_P/D_{P0} = m^{1/2}$	$P = 3.15$, $N_P = 20$, $D_P = 6.3$ in., and $F = 0.10$-in.
2. Constant diameter; face widths related by $F/F_0 = m$	$P = 100$, $N_P = 20$, $D_P = 0.2$-in., and $F = 100$ in.
3. Equations 1 and 2	$P = 10$, $N_P = 20$, $D_P = 2$ in., and $F = 1$ in.

Actually, Equation 2 leads to successive pinions that are scale models of each other; tooth pitchline thickness and face width maintain a constant proportion. Good design for one pinion and gear will usually suffice for all.

CONTEMPORARY DESIGN

Engine Features High Power For Displacement



OF LARGE-BORE, short-stroke, overhead-valve design, a new four-cylinder Ford industrial engine is said to develop unusually high horsepower per cubic inch of displacement in its weight and size class. With only 172 cubic inches displacement, the engine develops 61 brake horsepower at 2800 rpm. Bore is 3.90 inches combined with a short stroke of 3.60 inches to cut piston travel and friction; lower fuel costs are said to result. High rigidity is provided by a deep-skirt crankcase. Pistons are of autothermic design produced from cam-ground aluminum alloy castings with steel struts for controlled piston-to-sleeve clearance. The engine is pressure-lubricated and has an adjustable-speed governor mounted on the crankshaft.

Engineering News Roundup

Nuclear-Powered Planes Within 10 Years, Says Expert

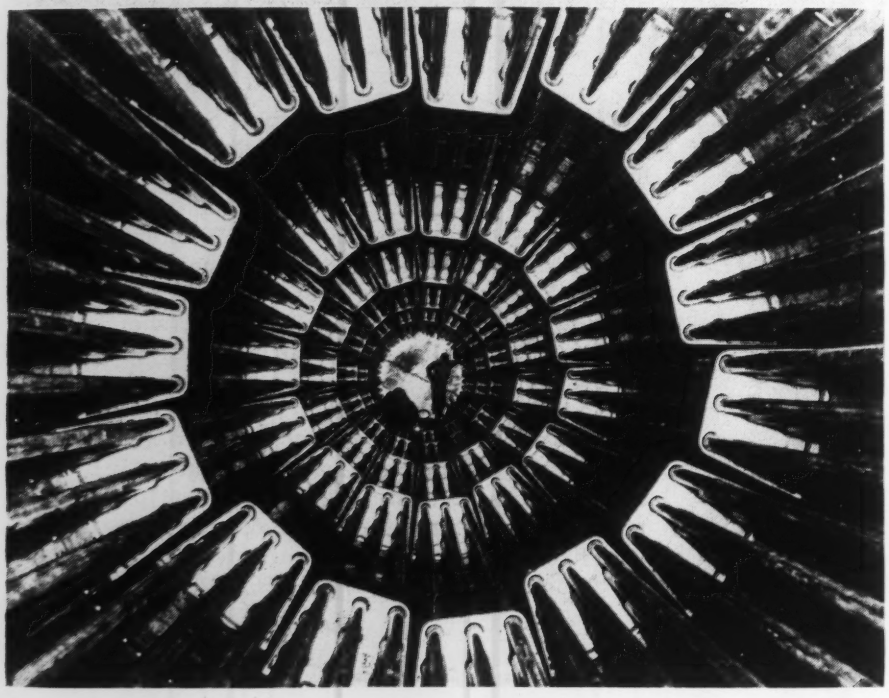
Nuclear-powered bomber planes will be flying within 10 years, says Hall L. Hibbard, vice president of engineering, Lockheed Aircraft Corp., and supersupersonic airliners carrying passengers coast to coast in less than two hours will follow "not too much later."

In addressing a recent state convention of the Air Force Association, Hibbard said that the planes will look little different than advanced types using piston and jet engines. Eventually, they will fly up to three times the speed of sound and will have "almost unlimited endurance, regardless of speed." A new concept of "divided shielding" will provide antiradiation safeguards for crew members at less weight than designers originally thought possible.

According to Hibbard, conventional propulsion engines such as turbojet, turboprop or rocket, will be used, and will obtain their necessary heat from a nuclear reactor. Divided shielding, consisting of a partial shield around the reactor and the remaining shielding around the crew flight stations will result in lighter total shield weight. Thus, nuclear aircraft need be no larger than some of todays' large military aircraft.

FIRST SILICON TRANSISTOR: First commercial production of silicon transistors has just been initiated by Texas Instruments Inc. Compared to germanium, the silicon transistors are said to have superior temperature stability and power handling characteristics. Although silicon is more common than germanium, production difficulties have previously restricted commercial development

LARGEST ROTARY DRYER: View of the interior of one of a group of rotary steam tube dryers 100 feet long and 10 feet in diameter shows part of the 23,700 square feet of heating surface in aluminum steam tubes. Made by General American Transportation Corp. for a chemical producer, the dryers each contain about 35,000 pounds of Alcoa aluminum. They are designed to dry fine solids such as rubber fillers and pigments

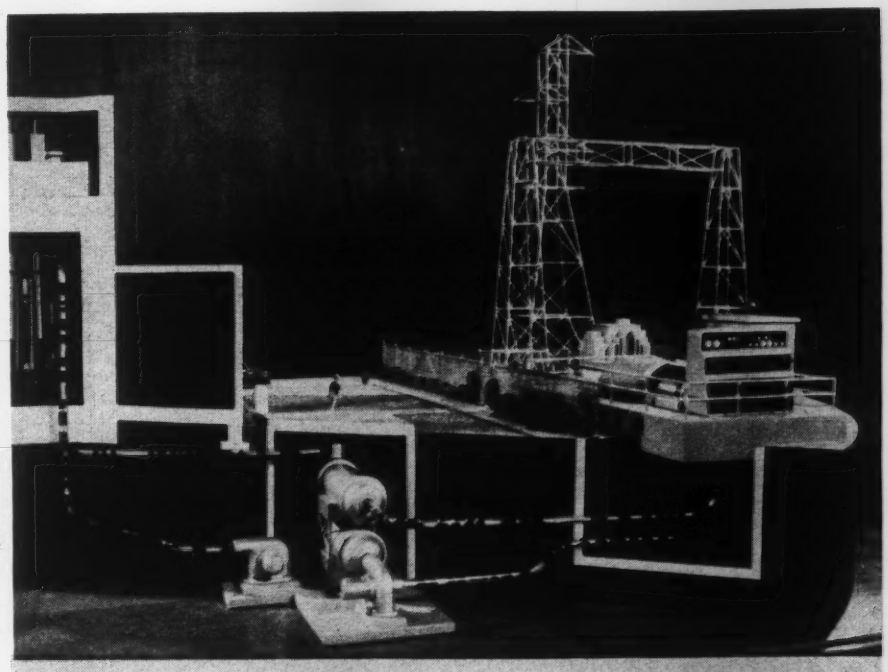


Six NBS Members Cited For "Project Tinkertoy"

Six members of the staff of the National Bureau of Standards have received the Department of Com-

merce Gold Medal Award for Exceptional Service. They are: J. G. Reid Jr.; Robert L. Henry; Dr. Benjamin L. Davis; Charles C. Rayburn; James G. Black Jr.; and Harold S. Horiuchi. Each award read in part "for outstanding contributions, as a member of a group, in the field of production technology for electronics with important implications for the electronics industry and for national defense."

These six men were the primary scientists engaged in the program formerly known as "Project Tinkertoy." The program consisted of the development of an automatic method for mechanical production of electronics and for the design and construction of machinery to mass produce electronic components on a pilot plant scale. Results of this project have received world wide recognition.



MODEL ATOMIC PLANT demonstrates how electrical energy may be produced with atomic power. Built by North American Aviation, the model will be shown in Philadelphia at the First International Instrument Congress from September 15 to 21, 1954. North American is prepared to build the full size plant for an estimated $10 million. Expected to generate about 8000 kilowatts of electrical power, the proposed plant will be used for the study of atomic power for industrial uses

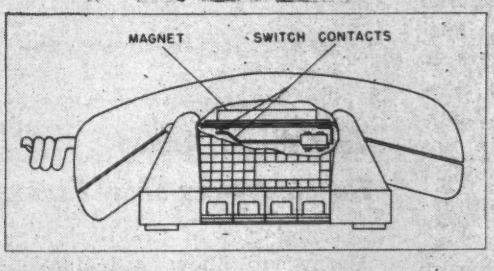
No Copper Shortage Says Industry Executive

Developments during the past two years have confirmed the belief that the much-heralded copper shortage has no substance in fact, declared Mr. Richard C. Diehl, President of the Copper and Brass Research Association recently. In view of the publicity given to an anticipated shortage of copper during the Korean emergency and the official urge at that time to substitute other materials for copper, it is important to emphasize at this time, according to Mr. Diehl, that copper is in ample supply.

Temporary shortages that developed, it is indicated, were largely the result of dislocations induced by various controls and restrictions imposed at that time. He added that such transitory shortages as may have been experienced in certain industries during that period, should not have been made the basis for the erroneous assumption that copper would be in short supply indefinitely.

Mr. Diehl, who is also President of Chase Brass and Copper Co. Inc., emphasized that there is every prospect that copper will be plentiful for many years to come. In fact, within two or three years, the available supply is expected to exceed the present by at least 15 per cent.

Concluding, Mr. Diehl pointed out that the entire copper industry is optimistic about the future, and that the supplies of copper and copper-base alloys in all regular commercial forms will be ample to meet all requirements.



SIMPLIFIED TELEPHONE designed with a Carboloy permanent magnet in the handset does not require the familiar "pop-up" buttons. Magnetic force attracts a movable steel plate in the base which actuates the switching mechanism. Developed by Connecticut Telephone & Electric Co., for private intercommunication use, the unit eliminates return springs, activating rods, plungers and retaining springs. Buttons at the bottom select the station to be called

AEC Approves Atom Power Reactor Studies

Separate study agreements have been made by the Atomic Energy Commission with three companies —American Machine & Foundry Co., Babcock & Wilcox Co., and Bendix Aviation Corp.—to bring to eleven the number of studies now being conducted by the individual concerns or groups of companies on industrial development of nuclear power.

All three companies have been

JET CHECKOUT: Surrounded by instruments and controls, engineers at Ford Aircraft Engine Div., test one of the world's most powerful jet engines, the J-57. Part of a new multimillion dollar testing facility recently unveiled in Chicago, the control rooms have two-foot thick concrete walls and observation windows of double-strength bullet proof glass. Control room is the heart of an intricate wiring system developed by Ford in conjunction with Minneapolis-Honeywell which links some 60-odd automatic testing instruments

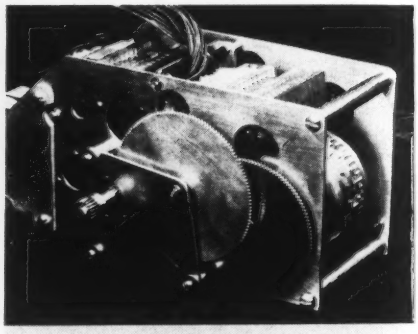
engaged for some time in nuclear power study. Babcock & Wilcox, manufacturer of power plant equipment, has designed and manufactured atomic energy equipment for the AEC. The company, which has recently established an atomic energy division with forty employees, will concentrate on design, development and manufacture of nuclear power plant equipment.

New uses for radioactive isotopes or fission products, and new reactor designs, will be the subject of Bendix Aviation Corp.'s study. American Machine & Foundry will concentrate on a development and manufacture of control mechanisms, and will explore the feasibility of developing low-power reactors for industrial research.

The three new projects will run for one year, with all costs borne by the companies. As with other contracts, title to inventions and discoveries and disposition of reports made on the studies will be determined by the commission, subject to certain license rights reserved to the three companies.

Automatic Machine Tools Subject of MIT Program

Automatic Control of Machine Tools will be the subject of a special two-week summer program to be held from August 23 to September 3, at Massachusetts Institute of Technology. Although not originally planned for the 1954 session, the subject was a last-minute addition to the regular MIT program as a result of "insistent demand," according to Professor Ernest H. Huntress. The program will be under the direction of Professor J. Francis Reintjes, Director of the MIT Servomechanisms Laboratory. Subjects will include: principles of information processing as applied to the use of machine tools; numerical control systems and their machine tool applications; equipment design, including data input and storage devices, computational equipment, servomechanisms, etc.; and design considerations for system reliability. Further information can be obtained from: Summer Session Office, Room 7-103, Massachusetts Institute of Technology, Cambridge 39, Mass.

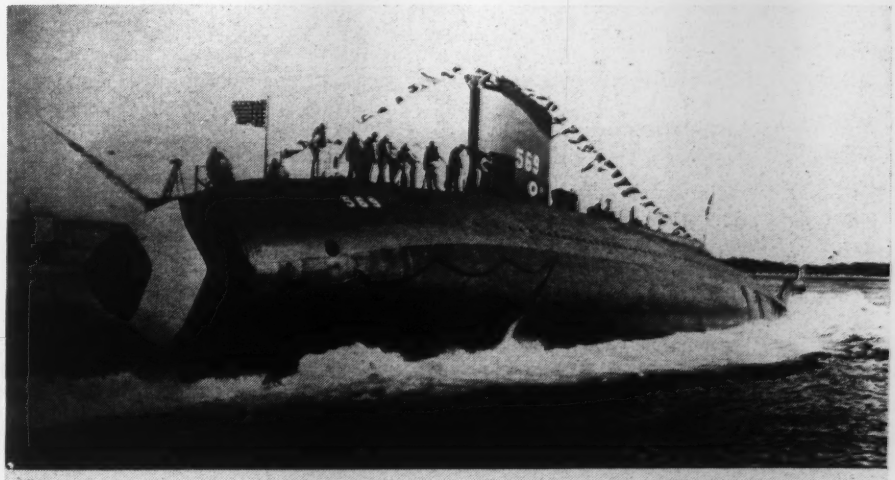


DIGITAL CONVERTER: Analog input is delivered to the driveshaft of this new Fischer & Porter Co. Digi-Coder converter, which delivers a digital electrical output. Coded drums, with "hills and valleys" corresponding to the output code are rotated by the gear system. Feelers traveling over the code wheel face close electrical contacts to produce the output signal. Unit is said to be the only converter with which decimal, binary, teletype, binary-decimal, or special output codes can be used

Tent Annex Added For Electronics Show Expansion

Popularity of the 1954 Western Electronic Show and Convention, according to Thomas P. Walker, vice chairman, has resulted in the addition of an 11,000 square foot tent annex. To be held from August 25-27 in Los Angeles' Pan-

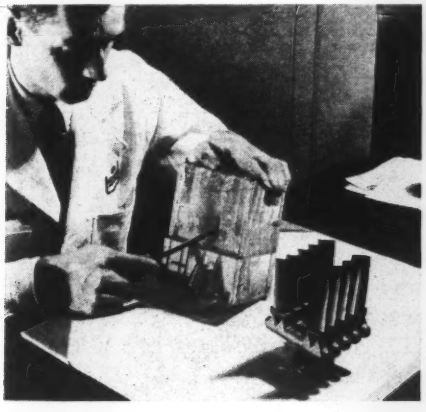
Pacific Auditorium and the Ambassador Hotel, the show already has 469 booths, and 50 booths are expected to be added. Attendance is expected to approach 20,000. Information can be obtained by writing the business office at 344 N. La Brea Ave., Los Angeles 36, Calif.



STREAMLINED SUBMARINE: Said to be hydrodynamically superior to any U. S. submarine yet developed, the *USS Albacore* will be faster submerged than any other submarine presently operating in the U. S. fleet. A result of airship research, the small experimental submarine requires less than one-half the shaft horsepower of a Guppy submarine to make the same submerged speed, compared on an equal volume basis. A conventional diesel-electric power plant is used. Cross sections are as nearly circular as possible, with extreme fairing of all appendages. Submerged speed is actually higher than surface speed

Unique Casting Method Produces Transparent Models

A novel and economical method for producing transparent models for use in fluid flow studies was recently reported by General Motors Research Laboratories. Transparent models have been made containing irregularly shaped in-



ternal cavities, of investment molds such as are used in casting buckets for jet turbine type engines. Although the plastic models were primarily developed for internal structures, such as occur in foundry molds, the methods seem to have application in many other areas.

With the method, a pattern for the required part is made of a low-melting-point alloy. A liquid, cold-pouring, thermosetting plastic is then poured around the metal pattern. When the plastic has set, it is heated until the metal pattern melts and drains out. Last traces of metal are cleaned out with acid. The transparent mold is then ready for use in flow studies.

Economy is the principal value of the development. Thin passages and irregular shapes, quite difficult to machine in other materials, are simply cast in the plastic.

In the casting studies, colored water is used in place of the molten metal, and high-speed motion-picture cameras are used to photograph water action as it flows through the mold in a simulated casting operation.

Fluorocarbon Plastic Ready After Five Years' Work

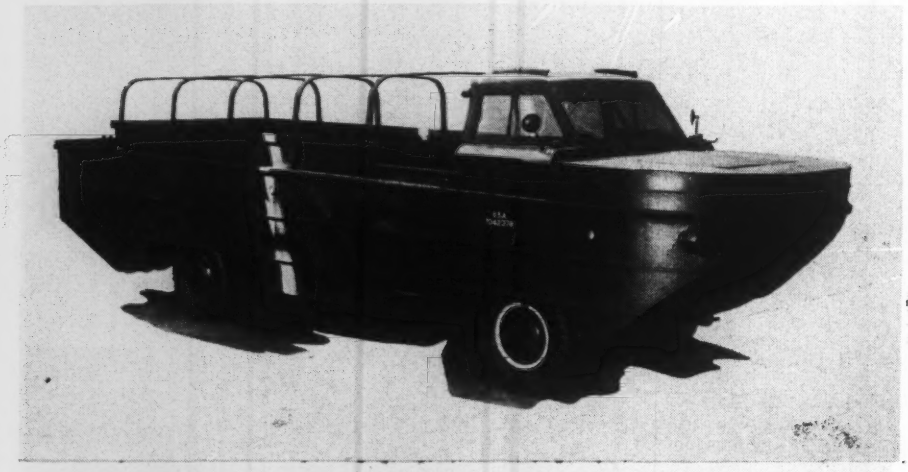
After five years of processed development, commercial production of fluorothene resins is now being undertaken by Bakelite Co. First announced some five years ago, the fluorocarbon plastic was previously produced by a batch method. A new continuous process plant at South Charleston, W. Va., will make possible a much higher volume.

Fluorothene is a plastic of the trichlorofluoroethylene type which has excellent heat resistance for a thermoplastic and withstands extremely corrosive chemicals such as fuming nitric acid. Volume resistivity is exceptional, particularly at temperatures in the range of 200 to 390 F. The material has low dielectric constant, high dielectric strength and good moisture resistance. Properties are said to be satisfactory from −320 to 390 F.

Current price of the resins ranges from $11 to $12 per pound in ton lots. A large part of the initial production will be used in military equipment, primarily as wire insulation, ammunition components, and as barriers to withstand corrosive chemicals. Largest uses are expected in the electrical and chemical equipment as wire insulation, tubing, electronic equipment components, and protective linings and coatings.

New Battery May Outlast Car

Expected to have a life of from ten to fifteen years, a nickel-cadmium battery is being offered to the public for the first time. Built by the Sonotone Corp. and distributed by Chrysler Corporation's Mo-



SUPER DUCK: New design for an amphibious truck, said to be far superior to the World War II model, was recently announced by GMC Truck & Coach Div. Rated at four ton capacity, the Super Duck carries nearly twice the pay load of the original model. Automatic central tire inflation permits the driver to select proper tire pressure for varying surface conditions. Road speed has been increased from 50 to 60 mph and water speed has been slightly increased despite higher weight

Par Parts Div., the battery is said to require water only about once a year. Overcharging, reverse charging or short circuits reportedly will not damage the battery and it is said to be capable of operating over a temperature range from −65 to 165 F. Other advantages claimed are its ability to withstand shock and vibration, and its ability to maintain most of its charge while stored for a year. A completely discharged battery may be 50 per cent charged in 15 minutes and completely charged in one hour, Chrysler reports.

Both positive and negative plates are made of grids of sintered Carbonyl nickel powder. A solution of potassium hydroxide is the electrolyte. Nickel oxide is the active material of the positive plate when charged and cadmium that of the negative plate.

Although it may be used in passenger automobile service, its recommended uses include commercial vehicles operating under extreme weather conditions and in industrial equipment. Police cars and other vehicles using radio equipment may find the battery useful.

Smaller than other batteries of comparable performance, a 6-volt nickel-cadmium battery is priced in excess of $100. In addition to the 6-volt battery, Chrysler is also distributing a 12-volt battery.

Heat-Sensitive Paint Is Thermometer in Color

Mapping of temperature distribution on hot surfaces with color can quickly be achieved with a German-made series of temperature indicating pigments. Supplied in powder form, these pigments are mixed with denatured ethyl alcohol and applied to the surface to be checked. As it reaches a designated temperature, the colors change and display a visual indication of temperature conditions on the entire surface simultaneously.

Said to be easier to use than thermocouples or surface pyrometers, the paint may be applied to moving parts and large or complicated surfaces. Odd-shaped hot spots of various sizes will show up quickly, designating underheated or overheated areas. Colors are said not to recede upon cooling.

Covering the range from 104 to 2462 F, the paint is accurate to ±9 F. Some of the colors make one change at a designated temperature, while others make up to four color changes. These latter may be used where a complicated heat distribution picture is expected. A few examples are listed in the accompanying table.

Color Changes for Typical Thermocolor Pigments

Thermocolor No.	Original Color	Changed Color	Color-Change Temperature (F)
With One Color-Change			
1	pink	blue	104
2	light green	blue	140
3	yellow	violet	230
5	white	brown	347
6	green	brown	428
8	white	brown	644
9	green	white	824
11	red-orange	yellow	1040
12	light green	black	1184
13	yellow	black	1310
14	yellow	black	1652
15	white	black	1832
With Two Color-Changes			
24	yellow	violet	554
	violet	brown	644
With Three Color-Changes			
33	yellow	black	347
	black	violet	554
	violet	brown	644
With Four Color-Changes			
41	light green	light blue	149
	light blue	yellow	293
	yellow	black	428
	black	brown	644

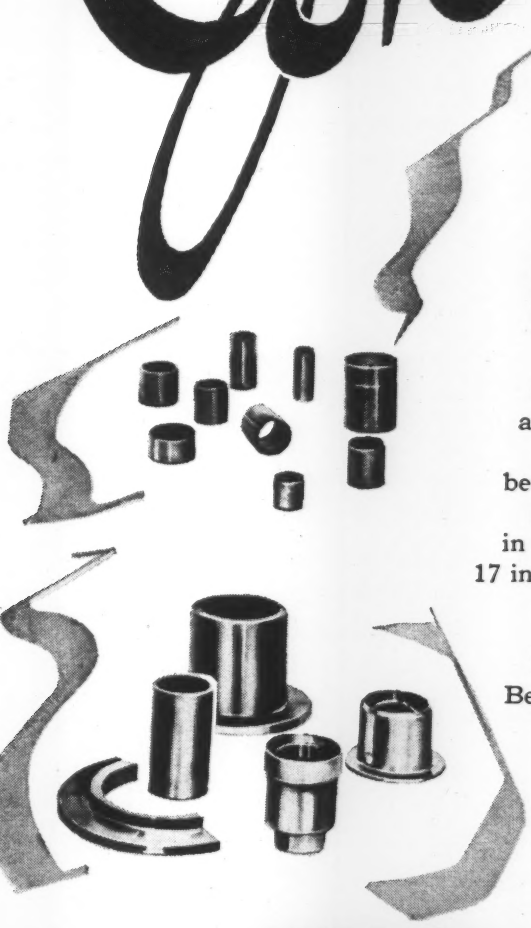
Heat distribution on internal combustion engines, stoves, ovens, furnaces and electrical equipment are a few of the uses listed for the paint. Pigments in the high temperature range are recommended for tests on jet engines and rockets.

Known as "Thermocolor," the paint is distributed in the United States by the Bryson Oil Co., Harriman, Tenn. A series of crayons whose marks change color at designated temperatures are also available for use in spot-checking temperatures on hot surfaces.

Cemented carbide parts as heavy as 4000 pounds can now be produced in a new 220-ton hot press recently installed by the Carboloy Dept., General Electric Co. Pieces of cemented carbide ranging in size from approximately 21 inches

Johnson

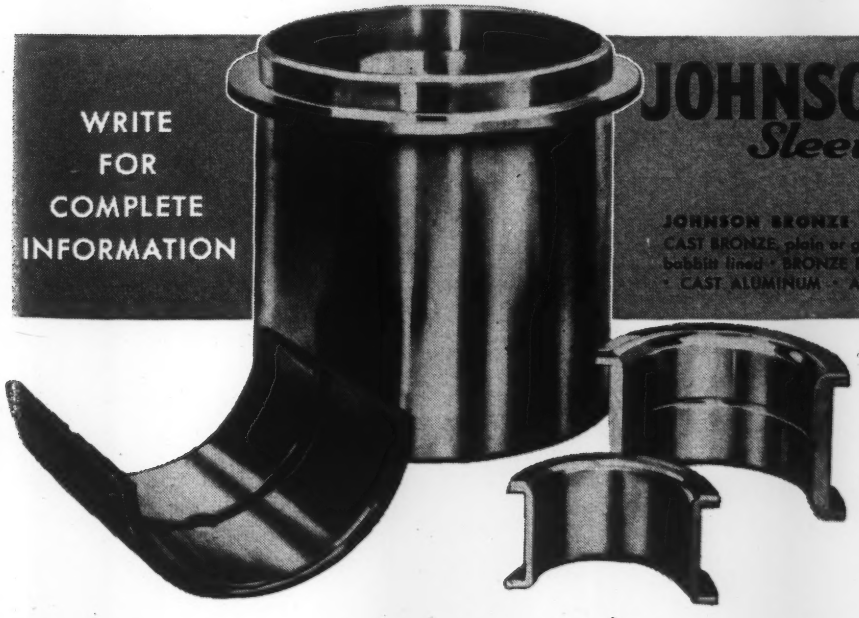
CAST BRONZE BEARINGS HAVE UNTOLD APPLICATIONS



There are thousands of applications where sleeve bearings cast from bronze alloys are the most practical, serviceable and economical. For over fifty years Johnson Bronze has been recognized as an outstanding source of supply for these bearings. Every month an immense quantity of cast bronze bearings is produced . . . in numerous styles and in a great range of sizes. Tiny bearings, ¼ inch or less in diameter, to "king size" bearings, 14 inches OD and 17 inches in length, are included in this huge production. Over 900 sizes of Johnson General Purpose GP Bearings are available from distributors' stocks; likewise a wide selection of Graphited Cast Bronze Bearings and over 340 EM Electric Motor Bearings. For special applications, Johnson engineers will gladly consult with you on style of bearing and alloy best suited and, if necessary, will help you design the bearing best suited to your needs.

JOHNSON BRONZE COMPANY
525 South Mill Street, New Castle, Pa.

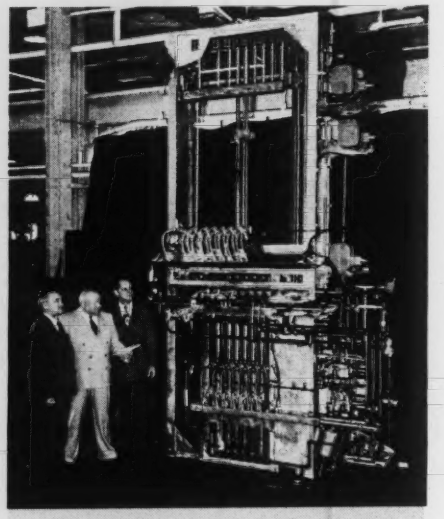
WRITE FOR COMPLETE INFORMATION



JOHNSON JB BEARINGS
Sleeve-Type

JOHNSON BRONZE PRODUCES ALL TYPES OF SLEEVE BEARINGS! CAST BRONZE, plain or graphited • BRONZE-ON-STEEL, copper-lead • STEEL BACK, babbit lined • BRONZE BACK, babbit lined • SHEET BRONZE, plain or graphited • CAST ALUMINUM • ALUMINUM-ON-STEEL • LEDALOYL powder metallurgy

Sleeve Bearing Headquarters since 1901



ATOMIC CLEANER: Used to clean radioactive heating rods, measure the amount of atomic zip remaining, and check their cases for leaks, the machine shown was developed by John S. Barnes Corp. for use on the G-E prototype atomic submarine engine. The machine's operation is entirely remote controlled, since it will be housed in a glass case filled with helium gas under pressure to cut down radiation

in diameter by 21 inches high to 7 inches in diameter by 5 feet high for wear resistant parts can be made.

Rubber Springs Bring Knee Action to Busses

Utilizing unique rubber torsion springing supplied by B. F. Goodrich, a 29-passenger intercity bus was recently driven in Akron to demonstrate its improved riding qualities. All four wheels are suspended on rubber in the new model manufactured by the Flxible Co. of Loudonville, O. Independently sprung front wheels with no front axle give the bus "knee action" which is said not to have been available before in buses.

The Torsilastic springs look like large steel pipes, and consist of a metal shell and central shaft with the space between filled with rubber. Springing is accomplished by the torsional movement in the rubber which is bonded to the metal. Either the shaft or the shell is held stationary while the other is partly rotated by a torque arm.

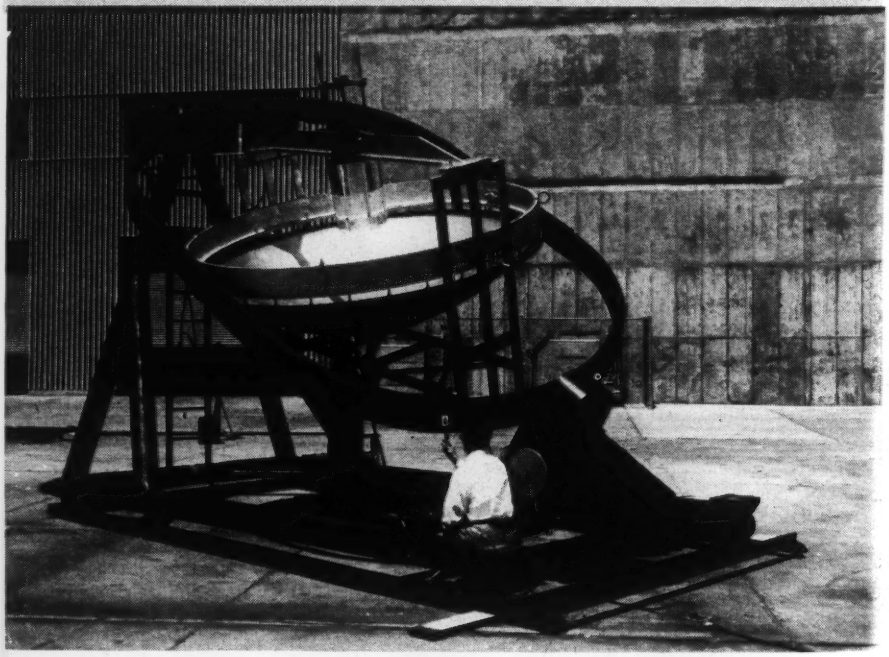
Eliminating metal-to-metal contact reduces road noise and vibration, it is claimed. There are no bearings to lubricate, no wearing action from dirt, and the spring does not develop squeaks or rattles.

Precision wire having cross sections of intricate or unusual design is now available from a New England manufacturer of precision wire products. From 0.022 to 0.1875-inch diameter wire forms of special design or specified accuracy are available from Heli-Coil Corp., Danbury, Conn. The new service is expected to interest spring manufacturers or wire mills for "specials," and companies requiring short runs not available through usual sources. Accuracy is said to be capable of being held to 0.0002-inch, with surface finishes in the range of 8 to 15 microinch rms. The cold roll-forming process employed can produce a work-hardened product up to 50 Rockwell C.

Aid for Specification Users

Designed to be of assistance to purchasers not equipped to make their own acceptance tests, the *Directory of Commercial and College Laboratories,* until now compiled and published by the National Bureau of Standards, will be published in the future by the American Society for Testing Materials. Every known testing laboratory will be requested to furnish information about its testing activities to provide directory information for companies wishing to check deliveries made on specifications, or seeking laboratory services in the evalua-

SOLAR FURNACE: Research on metals and ceramic materials is expedited at Convair's San Diego Div. by the largest solar furnace in this country. The 120-inch polished parabolic reflector made of ¼-inch aluminum forms a 5/16-inch diameter image of the sun. Under ideal conditions the furnace can develop a temperature of 8500 F (oxyacetylene torch, 5800 F), or approximately 85 per cent of the temperature of the sun's surface



Specify

GITS *Unit** SEAL

Result:

Economy

"Economy . . . counts not in savings but in selection."—*Edmund Burke*

Economy through Efficiency

Gits Unit Seal proves itself in dependable performance over a wide range of operating conditions—including extra-high speed, heat and pressure applications. Operation at peak efficiency always means dollars-and-cents savings.

Economy through Adaptability and Versatility

Gits Unit Seal fits many applications as a standardized item actually carried in stock. You harness the savings of mass production to your own specific needs. Gits Unit Seal already has wide application in the following fields: Washing Machines, Disposal Units, Gear Motors, Speed Reducers, Aircraft Turbine Pumps, Accessory Drive Units, Jet Propulsion Units, Electrical Power Equipment, Automotive Accessories, Business Machines, Standard and Special Machine Tools.

Economy through Long Life

Gits Unit Seal is designed for maximum life in any recommended application. Here's the real "proof of the pudding" in saving money.

Write Today For FREE Illustrated Brochure, or send us your seal problem. Our experienced engineering staff is at your service.

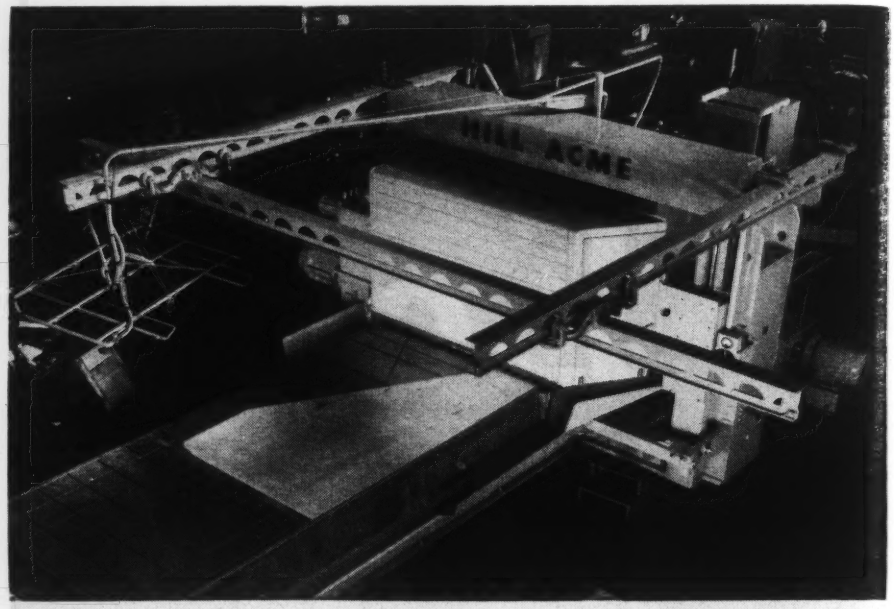
*Cartridge Seal . . . requiring only 25% more space than lip-type seals.

GITS BROS. MFG. CO.

1868 S. Kilbourn Avenue Chicago 23, Illinois

tion of raw materials and finished products. The present *Directory*, NBS Miscellaneous Publication M187 published in 1947, will continue to be available from Superintendent of Documents, Government Printing Office, Washington 25, D. C., until the revised ASTM *Directory* is completed.

Norman K. Anderson has been named general sales manager of the Warner Electric Brake & Clutch Co., Steven P. J. Wood, president, recently announced. Anderson who had been manager of the firm's industrial division, joined Warner in 1946.



WORLD'S LARGEST abrasive belt grinder has just been completed by the Hill Acme Co. of Cleveland. Using a belt 86 inches wide, it will be used to machine flat and tapered aluminum aircraft wings and fuselage skins accurately. Waterproof cloth abrasive belts are used with a coolant to prevent critical temperatures from being developed. The 16-foot long, hydraulically operated table permits grinding the entire width and length of the aluminum plate through each pass

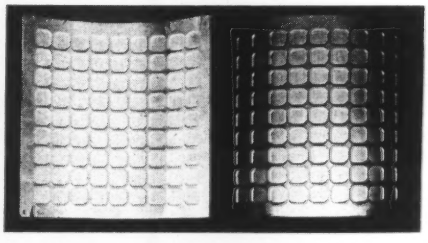
TITANIUM BLADES: Replacing alloy steel in helicopter rotor blades, titanium will be evaluated this summer as a skin covering. A ship-set of six blades uses only 52 pounds of titanium, with a resultant overall weight reduction of 68 pounds, according to Prewitt Aircraft Co. As reported by Titanium Metal Corp. of America, the weight saving is brought about because blades are mass-balanced at a point one-fourth the width of the blade from the leading edge. Thus for every unit of weight saved aft of this point, a three-fold weight reduction results in the forward portion

New Chemical Process "Machines" Accurate Parts

Precision milling of components without machinery can now be accomplished with a new chemical milling process originated by North American Aviation and developed in conjunction with Turco Products Inc.

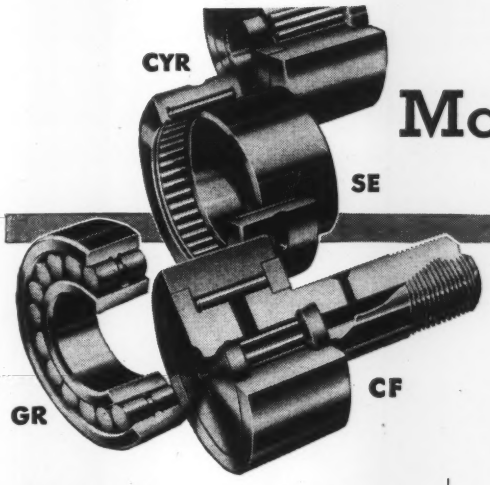
The chemical milling method, called the "Chem-Mill Process," removes excess metal from complex or fragile formed parts without danger of warpage that might result from machining. The method is said to be equally effective in making intricate cuts and in tapering metal.

So far, Chem-Mill is being confined to aluminum alloys, although its application to other metals is being developed. To pre

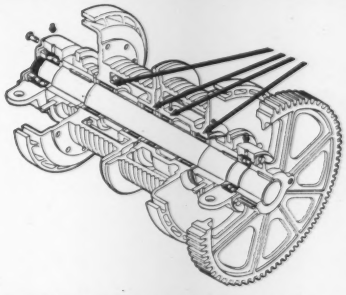


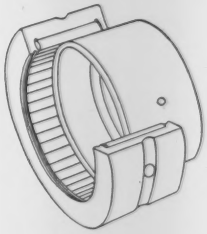
Typical parts are curved waffle type grids, almost impossible to produce by machine milling. Parts are matched at islands to produce a stiff sandwich structure

Metal is first masked by painting with special chemical compounds. Unmasked portion is etched away at a controlled rate

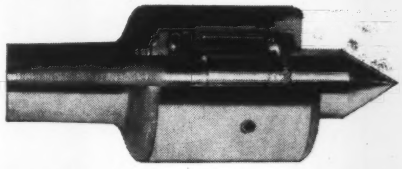


McGILL BEARING BRIEFS



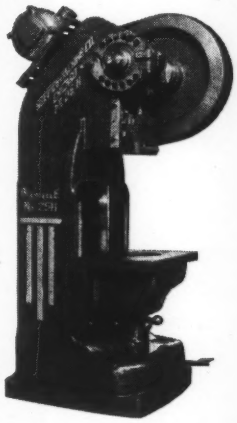


MOTOR TOOL LIVE CENTERS DEPEND UPON McGILL FOR HIGH RADIAL ACCURACY



Multirol SE Bearings, press fitted into Motor Tool Live Centers, "account for accuracy and long life of these units." They take the radial loads of lathe, screw machine and grinder operation without radial looseness or play.

ROUSSELLE PRESSES USE MULTIROL SE BEARINGS EXCLUSIVELY FOR 8 YEARS



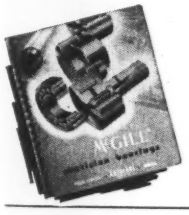
Service Machine Co., Chicago, have used Multirol SE Bearings exclusively for over 8 years on their Rousselle heavy duty presses. Two SE Bearings mounted side by side, support and carry the heavy fly wheel load on all 15, 25, and 40 ton models.

MULTIROL® SE Bearings
CARRY HEAVIER LOADS MORE ECONOMICALLY
On Baldwin-Lima-Hamilton Cranes and Shovels

The heavy cable loads on the Hoist Drum Shaft of Cranes and Shovels require a heavy duty bearing that occupies a minimum of radial space. The Multirol SE Bearing provides the answer to dependable performance in this application. Its trouble-free operation under heavy loads with long life expectancy has effected considerable savings in service charges for users of Lima Cranes, Shovels, Draglines and Pull Shovels.

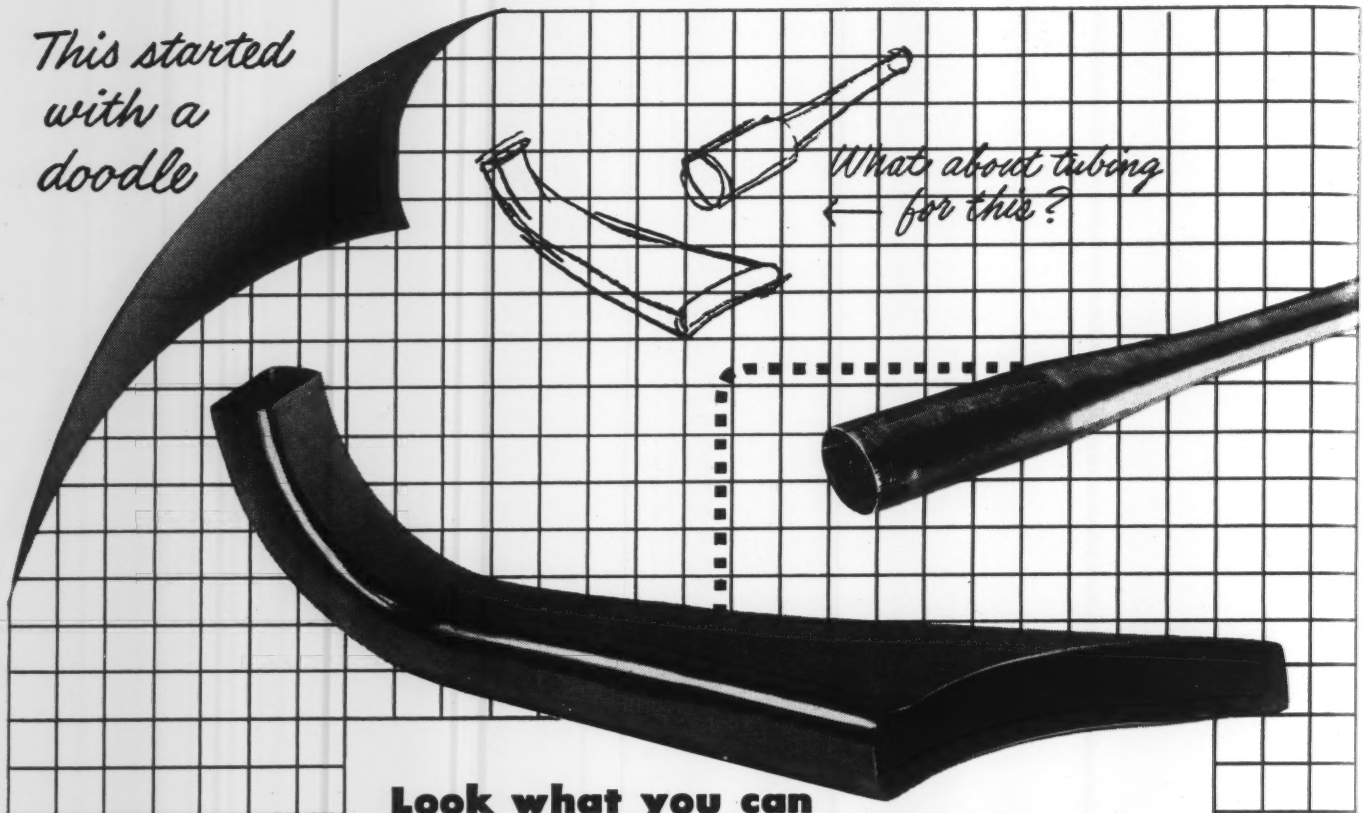
By packing more load carrying capacity into a smaller radial space, Multirol Bearings permit use of a larger shaft and a heavier drum section. This eliminates the tendency for the crushing load of the cable to bind the shaft and reduces shaft deflection.

Baldwin - Lima - Hamilton has been using Multirol Bearings for many years and depends on such design advantages as lubrication reservoirs above roll ends, one piece outer and roller retaining end shoulders, the sealing effect of close end shoulder and shaft clearance against foreign particles, etc. To get the same dependable and long lasting performance in your products, always specify McGill Bearings.



BEARING SELECTION GUIDE
A new 140-page Bearing Selection Guide, complete with 30 pages of vital engineering data, has been released by the McGill Manufacturing Co. Ask for Catalog No. 52.

McGILL® — **Precision Bearings**
McGILL MANUFACTURING COMPANY, INC.
200 N. Lafayette Street, Valparaiso, Indiana



Look what you can do with Stainless Steel Tubing

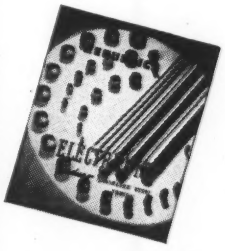
Ever try to make a tapered, rectangular tube with a bend in it? That was the problem which faced Configured Tube Products Company of Chicago when an order was received for a stainless steel spout for a cream separator.

Of course, you can cut out a blank, form it, bend it and weld it. That's the hard way. Too many expensive operations.

Configured Tube Products did it by starting with a length of Republic ELECTRUNITE Stainless Steel Tubing. Using an exclusive Republic process, the round tube was configured to the tapered shape shown above. This process controls the wall thickness, keeping it uniform, and makes possible a smooth, wrinkle-free bend.

The tube is shaped on special equipment, cut and polished. The result: a cream separator spout with a smooth surface free from contaminating imperfections . . . and at a reasonable production cost.

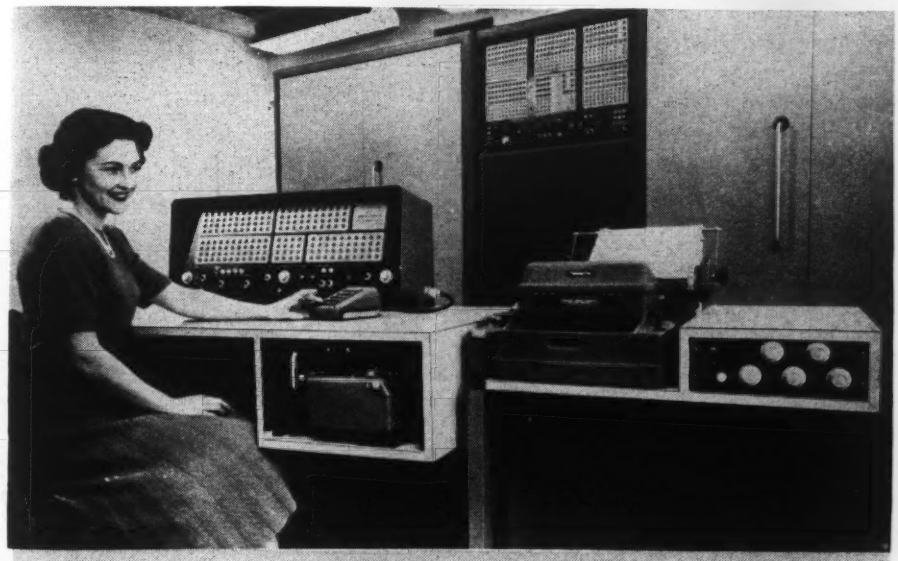
Does this give you an idea? Perhaps your product would be cheaper to produce. Or give better service. Or open up new markets if it were made from stainless steel tubing or pipe. Republic engineers will be glad to help you design with ELECTRUNITE Stainless Steel Tubing. Ask your Republic Salesman to make the arrangements.



Write for your copy of this informative booklet. It contains extensive data on how to design with ELECTRUNITE Stainless Steel Pipe and Tubing.

REPUBLIC STEEL CORPORATION
Steel and Tubes Division
217 East 131st Street, Cleveland 8, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, New York

REPUBLIC STEEL
ELECTRUNITE TUBING



LOW-COST COMPUTERS: Starting with the Model 203 Electronic Digital Computer said to be "designed to bring high-speed electronic data processing to business, industry and science at low cost," a newly formed company will specialize in computer design and manufacture. Formation of ElectroData Corp. as a subsidiary of Consolidated Engineering Corp., with headquarters in Pasadena, Calif., was recently announced

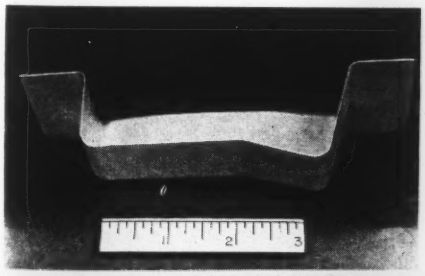
pare a part for chemical milling, the metal to be removed is left exposed, while the rest of the part is masked with a specially developed coating. The entire part is then submerged in an etching solution, which evenly attacks exposed surfaces at a constant rate until the desired amount of metal has been etched away.

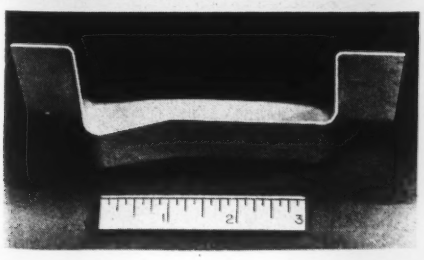
Electronically controlled, the chemical "machining" process produces finished metal surfaces to accuracies of 0.002-inch. Parts are said to emerge from the chemical bath smooth and perfectly formed.

Stiffened construction of wings or fuselage, allowing cooling or heating passages if needed, is one of the applications of the new method. "Sandwich" or "waffle" construction can be produced without machine-forming complex curves and angles. It is claimed that the process can be used for precision contouring of forgings or to produce intricately shaped and curved aluminum sheets, permitting redimensioning of parts to closer tolerances.

Other metals to which the process has been experimentally applied are steel, stainless steel, and titanium. Turco Products, which manufactures the basic chemical compounds, is licensed to make the process available to other manufacturing companies.

Aircraft and missile parts can be reduced from heavy to light gage without the use of machinery. Heavy-gage metals can thus be used to draw parts to desired form without cracking, and can then be "milled down" to a uniform thin-walled part



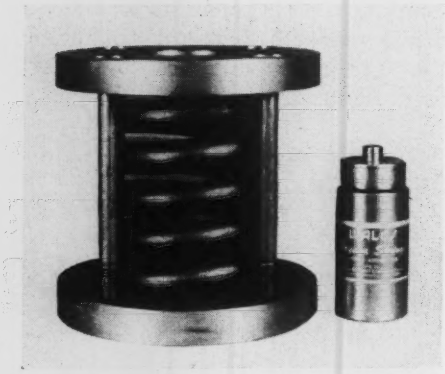


Springs to Skin Cream From New Silicone Fluid

Versatile enough to resist mechanical shear breakdown in mechanical devices and to increase water repellency in cosmetic preparations, a new family of silicone fluids called Viscasil fluids has been made available commercially by General Electric. These high-viscosity fluids are said to exhibit an extremely small change in viscosity at temperature extremes. G-E engineers also claim unusual chemical inertness and compressibility.

Use of the new fluids in fluid couplings, torsional vibration dampers, shock absorbers and similar mechanical devices has successfully established their high resistance to mechanical shear breakdown. Because of their purity, water repellency, physiological inertness and stability, they are expected to find wide application in cosmetics, pharmaceutical and protective skin creams. They may also be utilized as release agents for

Using Viscasil fluid as the damping medium, this Houdaille - Hershey torsional vibration damper is designed to dampen excessive vibrations set up in the crankshafts of trucks, tractors and other vehicles



Use of G-E's new Viscasil silicone fluid in the Wales preloaded Hydra Spring, right, enables it to have the same characteristics with respect to force, stroke, initial and final loads as the big caged railroad type spring at the left

rubber, plastics and metals, and in such applications are said to afford fewer maintenance problems, longer mold life and reduced part rejection. In addition, they prevent the adhesion of sticky materials to rolls, mixers and other parts, and release ice from rubber or metals.

New Plastic Produced for Pressure Sensitive Adhesives

Production on a development scale of vinyl ethyl ether polymers, used as a base for pressure-sensitive adhesives, is being initiated by the Bakelite Co. Characterized by stability, lack of color, and uniformity, the new polymers will be produced in commercial quantities.

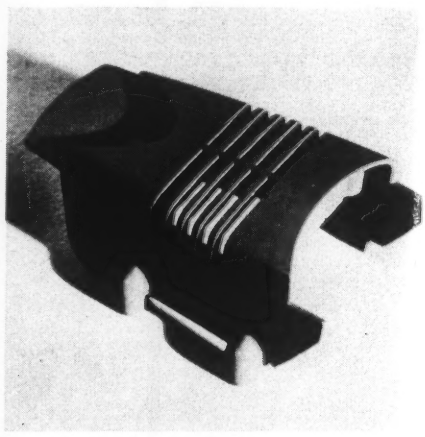
The new polymers are being offered in two molecular weights—relatively low molecular weight, which is extremely viscous liquid at room temperature, and medium high molecular weight, which is a rubber-like solid with a faint tack. Feeding tests conducted on laboratory animals indicate that toxicity should not present a problem because of its low magnitude.

Michigan Steel Casting Co., Detroit, Mich., announces appointment of Jack Bean as President-General Manager; Harold Schroeder, Vice-President-Operations; Walter Hakin, Vice-President, Sales; and Elry Christensen, Sales Manager. One of the pioneer producers of heat and corrosion resisting alloys, the company was recently reorganized with greatly increased capacity to produce stainless steel alloys only.

Flexible Molds Cut Plastic Casting Cost

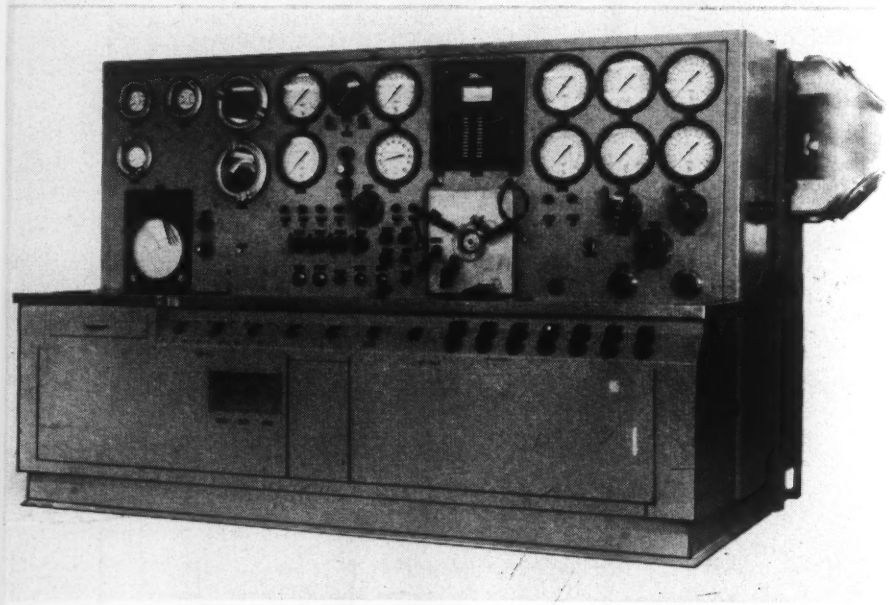
Cutting costs as much as 90 per cent, a new flexible mold process for casting plastic parts has been developed by General Electric. Made of plastisols based on Bakelite vinyl resins, the molds are said to reduce production time by more than 60 per cent. These plastisols, produced by Elastomer Chemical Corp., permit simplified casting of intricate details and thin wall sections.

According to General Electric's Small Appliance Div., cost of casting a dozen sample parts from a temporary metal mold was as high as $3000. Using the flexible mold, cost is reduced to about $300. In comparing plaster molds with the new process, GE claims it takes only 1½ hours to make a simple flexible mold while the same plaster mold requires 4 hours to complete. More intricate molds take 16 hours to make from plaster as compared to about 5 hours for the new molds. Those requiring several different pieces when made of

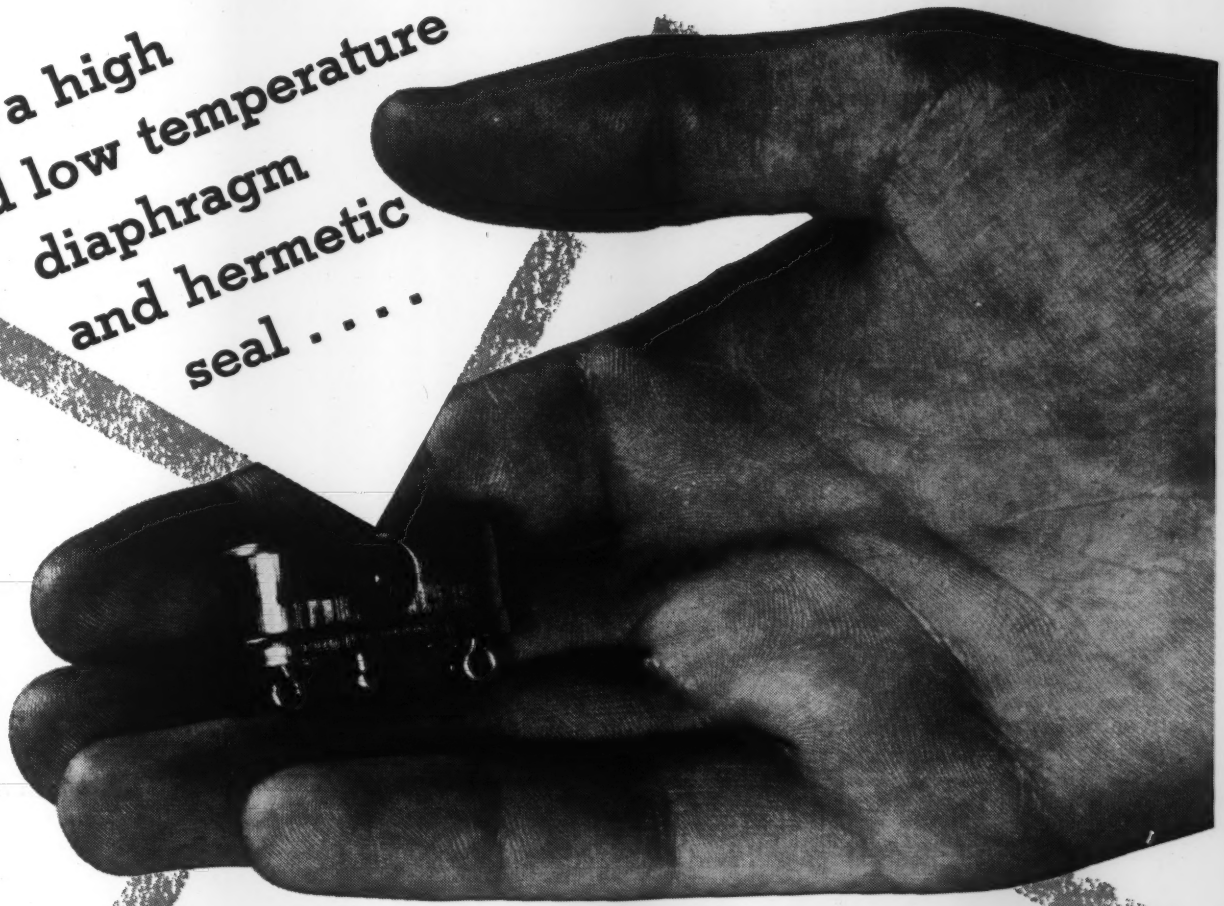


New flexible mold process developed by G-E may be used to cast prototypes of items such as fan motor or reactor housings

COMPLEX TEST STAND for testing jet engine fuel regulators simulates all in-flight conditions affecting their performance. Designed by Greer Hydraulics, the unit permits complete evaluation of the regulators of the General Electric J73 turbojet engine. Precise control of pressure and temperature is provided as well as accurate indication of pressure, flow, speed, voltage and temperature



As a high and low temperature diaphragm and hermetic seal . . . .



SILASTIC Stays Elastic

By using a Silastic* diaphragm, Haydon Switch, Inc., of Waterbury, Conn., has produced a hermetically sealed snap-action switch that weighs only about half an ounce and gives maximum life and reliability. It also operates with less than half the effort required by standard "aircraft quality" switches.

The Silastic diaphragm remains so flexible that the operating force on the actuator need not exceed 32 ounces even at —90 F. Fatigue problems and subsequent unreliability associated with metal diaphragms are also eliminated. Operational life in the range of a million cycles is far in excess of the best metal diaphragms or bellows.

Accelerated permeability tests indicate that an effective hermetic seal is maintained for more than 10 years. Internal pressures up to 100 psi have failed to produce leakage or rupture, and no change in the diaphragms has been observed even after 72 hours' immersion in salt, fresh, or soda water, or in automotive or AN-0-6 aircraft oil.

Originally designed for aircraft, fire control and guided missile service, the new miniature switch is being applied to domestic and commercial washing machines, machine tools and other equipment exposed to liquids or moisture.

That's the kind of performance that has established Silastic as an ideal diaphragm material where pressures must be maintained despite temperature extremes, weathering and oxidation, or in contact with a variety of oils and chemicals. Silastic is also unique among resilient dielectric materials because it combines high thermal conductivity with excellent resistance to moisture, corona, and to fatigue.

That's why, if you need a rubberlike material that retains its dielectric properties and its resilience at temperatures from —100 to 500 F. it pays to consider Silastic first.

*T. M. REG. U. S. PAT. OFF.

DOW CORNING CORPORATION
Midland, Michigan

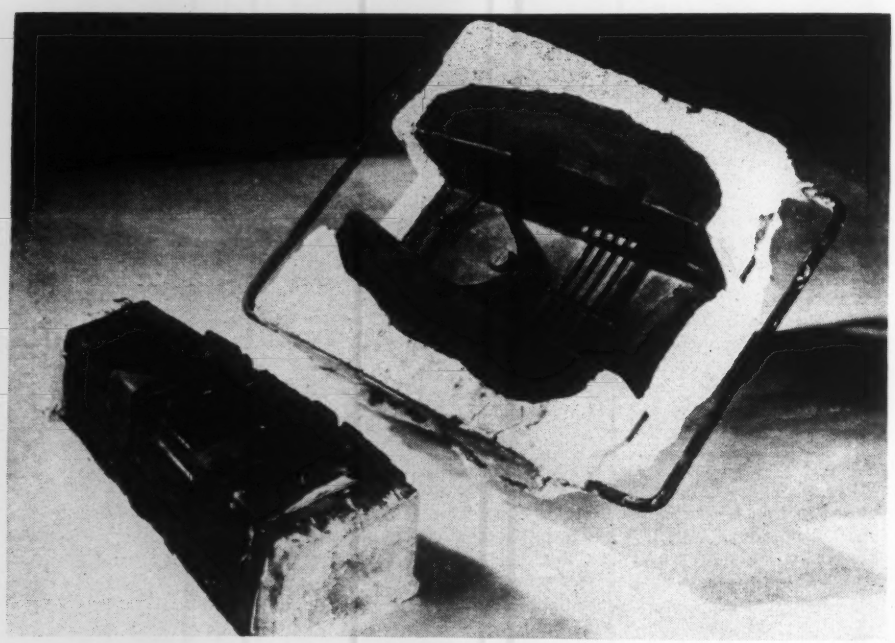
first in Silicones

MAIL COUPON TODAY for data on the properties, performance and applications of Silastic.

Dow Corning Corporation, Dept. P-18, Midland, Michigan
Please send me:
- ☐ Silastic Facts 10a, properties and applications of Silastic stocks and pastes.
- ☐ List of Silastic Fabricators.
- ☐ "Tall Tales and Fabulous Facts," a 24-page booklet on the properties of Dow Corning Silicones.

NAME _____ TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____
STATE _____

ATLANTA CHICAGO CLEVELAND DALLAS DETROIT LOS ANGELES NEW YORK WASHINGTON, D. C. (Silver Spring, Md.)
Canada: Dow Corning Silicones Ltd., Toronto England: Midland Silicones Ltd., London France: St. Gobain, Paris



Flexible molds and core pieces (above) are sometimes backed up with plaster forms to prevent shrinkage or distortion and maintain accuracy of dimensions when casting larger parts

plaster can now be made in one piece because of the flexibility of the plastisol.

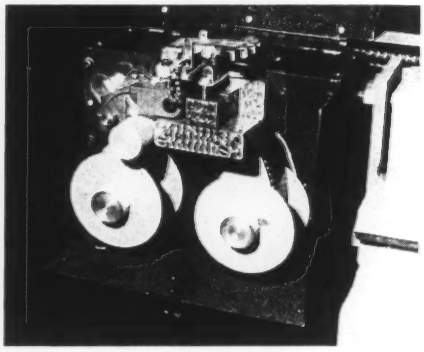
While not more than four prototypes can be cast from a simple plaster mold before it must be renewed, the new process is said to allow up to 40 castings to be made. The new mold will not be damaged by castings of phenolic or epoxy resins and castings are uniform throughout the entire run.

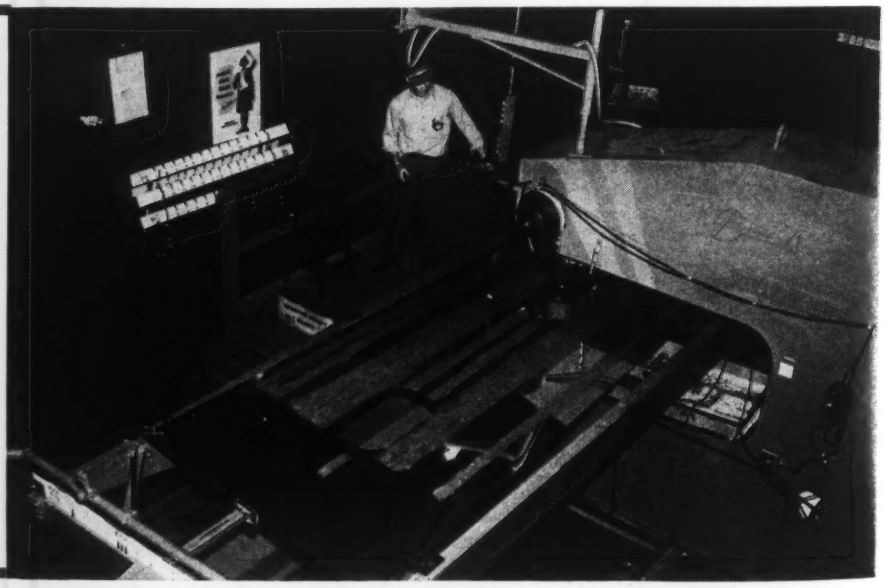
Automatic Riveting Machine Controlled by Movie Film

Ordinary 36-millimeter motion picture film is used to control riveting operations on a new machine at Convair's San Diego Div. Developed jointly by Convair and General Riveters Inc., the machine uses a five channel film-index control system in which the motion picture film is perforated by the indexing device on the first set-up. It is said that five times as many automatic operations can be accomplished as compared with previously used photoelectric indexing systems.

Three films control the riveting operations. A large spool controls the longitudinal run and cues two others positioned at opposite ends of the work bed, which in turn control the transverse run. Specially designed clutches maintain even tension in the film as it unwinds. Mechanical "feelers"

Heart of the riveter is a 35-millimeter film indexer. Short lengths of film, whose movement is coordinated with the riveting head, are perforated to control transverse feed, and are used in conjunction with a large film spool which controls the longitudinal run





Movie film-controlled automatic riveting machine handles complete riveting runs on aircraft parts at Convair. Presently setup for handing relatively flat panels, the Drivmatic riveter can also be used for contoured assemblies

DELCO MOTORS

the best running mate your product can have

In this pushbutton age, millions of Delco motors supply the actuating power to operate the appliances, tools and equipment that help to create our American standard of living.

This widespread use of Delco motors is convincing testimony to their outstanding, dependable performance. Popular endorsement on such a broad scale suggests that a Delco motor is the best running mate *your* product can have.

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find the punched holes in the film and relay the information to the drilling and riveting head.

Capable of clamping work pieces tightly, the machine also drills, countersinks, selects the proper rivet, inserts it, and sets it, all from one starting signal. Hand operations are completely eliminated.

National Industrial Leather Association is the new name for the former American Leather Belting Association. Organized originally as a trade association for manufacturers of flat leather belting, the organization has extended its activities and membership to include manufacturers of mechanical leather packings, textile and other industrial leathers. Headquarters will continue to be maintained at 320 Broadway, New York 7, N. Y.

Delta Fin Design Improves Heat Transfer

A new fin design which is said to improve the efficiency of extended heat transfer surfaces has been announced by the Trane Co. Used with flat fins or in front of each row of tubes in multirow coils, the new design consists of a delta-shaped (triangular) ridge formed near the leading edge of the fin surface or placed as a separate unit in front of each coil. The delta ridge increases air turbulence over the entire fin surface, reducing the insulating film or "dead" air present on some flat-fin types.

Addition of the delta ridge is also said to increase fin strength and help to protect the coils from damage caused by rough handling. The new Delta-Flo fins are mechanically bonded to coil tubes in a solderless joint that is claimed to be as strong as the metal itself and to provide excellent heat transfer efficiency.

Meetings and Expositions

June 13-18—

American Society for Testing Materials. Annual meeting and exhibit to be held at Hotels Sherman and Morrison, Chicago, Ill. Robert J. Painter, 1918 Race St., Philadelphia 3, Pa., is executive secretary.

June 14-15—

Malleable Founders' Society. Annual meeting to be held at the Seigniory Club, Province of Quebec, Canada. Additional information may be obtained from society headquarters, 1800 Union Commerce Bldg., Cleveland, O.

June 14-17—

American Society of Mechanical Engineers. Oil and Gas Power conference to be held at Hotel Muehlebach, Kansas City, Mo. C. E. Davies, 29 West 39th St., New York 18, N. Y., is secretary.

June 20-24—

American Society of Mechanical Engineers. Semiannual meeting to be held at the William Penn Hotel, Pittsburgh, Pa. C. E. Davies, 29 West 39th St., New York 18, N. Y., is secretary.

June 21-23—

American Management Association. General management conference to be held at Hotel Statler, New York, N. Y. James O. Rice, 330 West 42nd St., is vice president-secretary.

July 12-15—

American Electroplaters' Society. Annual convention to be held at Hotel Statler, New York, N. Y. Additional information may be obtained from society headquarters, 445 Broad St., Newark 2, N. J.

Sept. 5-8—

Pressed Metal Institute. Annual fall meeting to be held at the Manoir Richelieu Hotel, Murray Bay, Quebec. O. B. Werntz, 2860 East 130th St., Cleveland, O., is managing director.

Sept. 7-9—

National Fluid Power Association. Fall meeting to be held at the Hotel Commodore, New York, N. Y. Barrett Rogers, 1618 Orrington Ave., Evanston, Ill., is executive secretary.

Sept. 8-10—

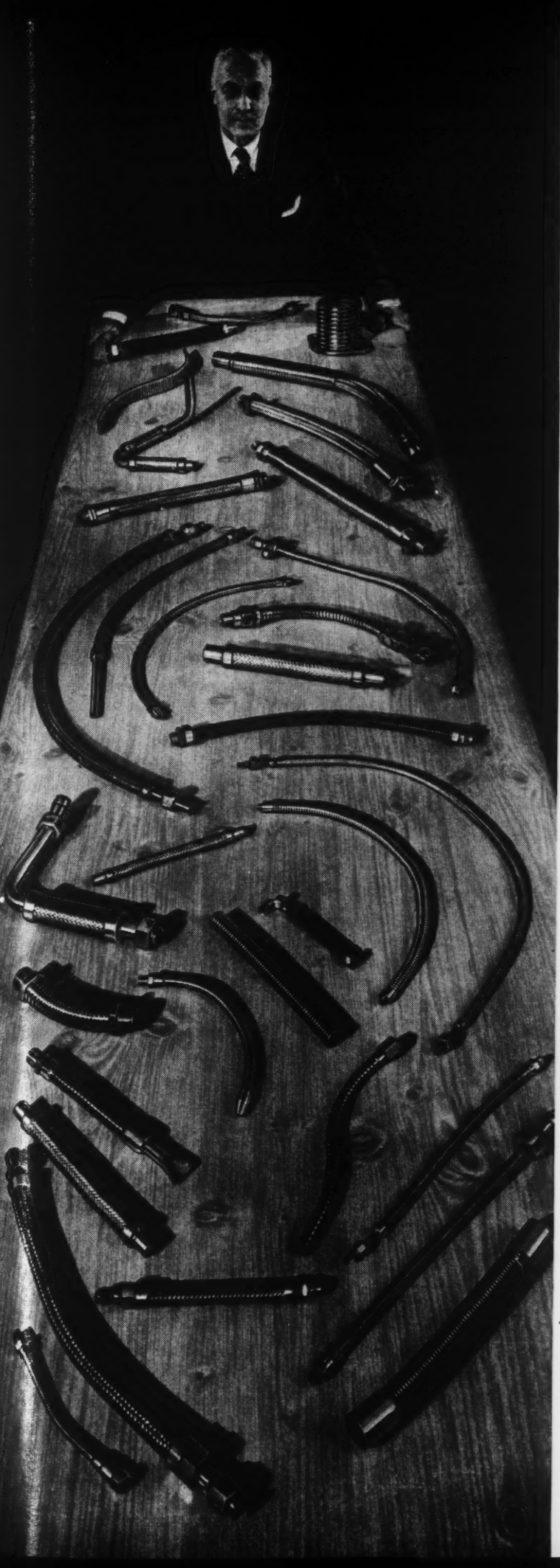
American Society of Mechanical Engineers. Fall meeting to be held at the Schroeder Hotel, Milwaukee, Wis. C. E. Davies, 29 West 39th St., New York 18, N. Y., is secretary.

Sept. 13-24—

Instrument Society of America. International instrument congress & exposition to be held at Convention Hall and Commercial Museum, Philadelphia, Pa. P. V. Jones Jr., 1319 Allegheny Ave., Pittsburgh, Pa., is secretary.

Sept. 21-23—

Society for Experimental Stress Analysis. Fall meeting and exhibit to be held at the Hotel Bellevue-Stratford, Philadelphia, Pa. W. M. Murray, P. O. Box 168, Cambridge 39, Mass., is secretary.



How much extra do you think special design cost on these flexible connectors?

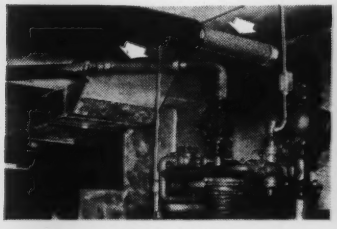
If you guessed one penny extra, you're wrong. "Ameri can" engineers designed these connectors, complet with special fittings, to meet specific requirements . . *at no extra charge!*

American Flexible Metal Connectors answer thou sands of problems in conveying steam, water, oil an other liquids, semisolids and gases. When planning new installations or starting a real money-saving effor to eliminate unsatisfactory connections—look first t American. *Special* design costs you nothing.

In working with flexible connectors over many years, American has made use of a variety of metals Bronze, Brass, Aluminum, Steel, Stainless Steel—in wide range of ID's—with end fittings adaptable to al types of connections. Let American's accumulated ex perience go to work for you.

5415

Here's the easy way to solve problems of . . .



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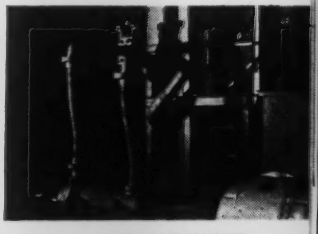

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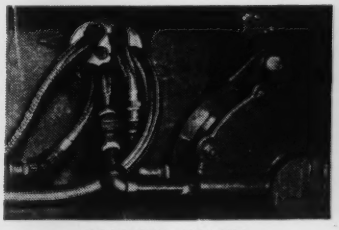
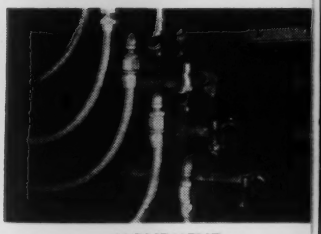


CRAMPED SPACES



MOVEMENT

WHEREVER CONNECTORS MUST MOVE

AMERICAN

flexible metal hose and tubing

an ANACONDA® product

The American Brass Company, American Metal Hose Branch Waterbury 20, Connecticut.

Please send me Booklet CC-400 which shows how America Flexible Metal Hose and Tubing is designed, installed and use

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HOW'RE WE DOING?

On January 1, 1954, we nailed our pledge of service to the mast. Here's what we promised—and here's how we've performed.

WE PROMISED—

1 To ship every single order for each and every one of our 1374 catalog items—right from stock—*the same day we got the order!*

2 To ship every order for "specials" within 4 weeks (or better) of the day the order arrived.

WE'VE DELIVERED!

1 We've shipped every 1954 order on 1373 catalog items the same day it was received. On the single exception—5/8" diameter Stainless Steel Cap Screws—we once were out of stock for a few days. But we fixed that one up fast—and now we're 100% perfect!

2 Our record is better than 98% perfect! Out of hundreds of orders for "specials" received this year, we've missed the promised shipping date on less than 2%. We've shipped most orders *earlier* than promised!

We've done it—and we're going to keep on doing it—thanks to the complete and continuing cooperation of every single Holo-Krome worker. Nobody's going to let this 99.44% perfect record be broken!

HOLO-KROME
Completely Cold Forged
SOCKET SCREWS

THE HOLO-KROME SCREW CORP.
HARTFORD 10, CONN.

Put us and our distributors to the test—again and again! We'll deliver!

HELPFUL LITERATURE
FOR DESIGN EXECUTIVES

1. Explosion Proof Motors

Lima Electric Motor Co.—Brochure descriptive of type EX explosionproof and type ED dust-tight motors is now available. Former is used in hazardous locations where gasoline, petroleum, naphtha, alcohols, acetone, lacquer solvent vapors and natural gas are present. Latter is applicable where hazardous grain, carbon black, coal or coke dusts exist.

2. Weldments

Graver Tank & Mfg. Co.—Typical examples of weldments fabricated by company are shown in 16-page brochure along with a description of facilities available for this type of fabrication work. How company has served the diesel engine, primary metals, mining and construction, metalworking, electrical and power machinery and alloy industries is effectively depicted.

3. New Tractor

Allis-Chalmers Mfg. Co., Tractor Div.—The WD-45 tractor featuring the Power-Crater engine is subject of 28-page booklet. Fourteen charts are provided which show feature components of the tractor, what it will do in the field and its price advantages.

4. Locknuts & Lockwashers

Standard Locknut & Lockwasher, Inc.—Tables of dimensions pertinent to locknuts, lockwashers and shafts are provided in 6-page folder 32. Nuts and washers are made to SAE and ABEC standards and are for ball and roller bearing applications.

5. Pushbutton Flush Latch

Hartwell Co.—Included in two-color bulletin descriptive of new pushbutton flush latch development are drawings of complete assembly and installation, procurement information and a parts list. Latch is important component to functional design for commercial, industrial, marine and aircraft applications.

6. Flexible Bellows

Flexonics Corp.—Manufacture, design, applications and specifications for Flexon bellows are covered in 16-page "Flexon Bellows Design Guide." These units, used as valve stem seals and in steam traps are available in stainless steel, Monel, brass and other metals, in sizes from $\frac{1}{16}$-in. ID to 12⅞ in. OD.

7. Thermosetting Plastics

American Cyanamid Co.—Cyanamid thermosetting molding materials, resins and resin adhesives, polyester resins and laminating resins receive descriptive treatment in 12-page brochure. Highlight is double page properties table which lists raw material characteristics, as well as physical, electrical and chemical properties.

8. Screw Thread Inserts

Heli-Coil Corp.—Suggestions for the designer of electric equipment on how to provide strong, wear resistant threads of stainless steel in soft insulating and conductive materials are contained in 4-page bulletin 664. Three cases where wire screw thread inserts produced threads for adjustable screws in acrylic and phenolic insulators and in copper conductors are described.

9. Giant Cap Screws

Standard Pressed Steel Co.—Prices for line of giant Unbrako cap screws are given in 4-page folder 2002 for diameters of 1⅛, 1¼, ⅜ and 1½ in. in lengths up to 12 in. Cap screws are hot forged of heat-treated alloy steel and are specially engineered for large presses and latest machine tools.

10. Insulating Varnishes

Minnesota Mining & Mfg. Co.—Complete data on established as well as newer types of insulating varnishes are provided in catalog. Feature section on "How to Use Insulating Varnishes" gives instructions on dipping, vacuum, pressure, brush, spray and baking types of application. Conversion tables, solvent charts, tank capacities and specific gravity correction tables are included.

11. One-Way Roller Clutch

Miniclutch Co.—In 4-page descriptive bulletin B-54 is depicted a line of miniature one-way roller clutches which permit drive in one direction with free-wheeling action in the opposite direction. Design and installation data are given for roller assemblies as well as complete clutches. Typical applications of one, two and three-clutch assemblies are included.

12. Protective Coatings

Industrial Metal Protectives, Inc.—Aid in determining the type of protective coating best suited to a particular corrosion problem is supplied by a comparison chart of 12 Zinclate coatings. Resistance of each to abrasion, acids, corrosion, dry temperatures, fire and other factors is covered and coverage, weight, surface preparation, etc., are described.

13. Variable Speed Drives

T. B. Wood's Sons Co.—Drive tables relative to variable speed drives with 5 and 7½-hp motors, 10 and 15-hp motors and 15 and 20-hp units are featured in 8-page bulletin 796. Data pertinent to companion sheaves and the Sure-Grip variable speed belts are tabulated as well.

14. Self-Lubricating Bearings

O & S Bearing Co.—Design of self-lubricating nonmetallic bearings is subject of 4-page illustrated bulletin. Typical applications for such bearings are covered, covering oscillating, rotating and sliding motions.

15. Titanium Tubing

Superior Tube Co.—Properties, applications and advantages of titanium tubing are presented in 8-page bulletin 42. Some of the research and development which went into the product is outlined, together with properties of titanium which make it promising for many new applications. Tube sizes, tolerances, chemical analysis and finishes, processing and fabricating characteristics are covered.

USE THE POSTAGE FREE CARDS BELOW for copies of anything listed on this or following helpful literature pages—or for further information on any items in the new parts section or the engineering department equipment section which you'll find on the next several pages.

For additional information on anything advertised in this issue, use the yellow cards in the front section of this magazine.

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22	44	66	88	110	132	154

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16. Balancing Machines

R. B. Annis Co.—Three available literature pieces respectively cover under-drive balancing machines, special purpose balancers and single plane balancers. Machines are used for balancing motor blower wheel and similar assemblies, impellers, flywheels, fans, clutches and similar rotating parts.

17. Threaded Inserts & Studs

Bardwell & McAlister, Inc.—The Rosan locking system which makes use of locked-in threaded inserts and studs is described in 32-page loose-leaf catalog. Tabulated data on thread sizes for both inserts and studs are provided. The Rosan locking system provides means for secure fastening into any soft material such as aluminum, wood, plastics, etc. When necessary, steel inserts and studs can be easily removed and replaced.

18. Air-Tube Cathead

Wichita Falls Foundry & Machine Co.—Detailed illustration of the Wichita air-tube cathead which will make up all oil drilling joints alike is featured in 4-page bulletin 111. A complete parts list is also provided. Cathead will pull all a line will stand without danger of breaking.

19. Two-Way Solenoid Valves

Automatic Switch Co.—Special bulletins 8268 and 8269 packless two-way solenoid valves in steel and all stainless steel construction are described as to operation, features and applications in data form 699. Dimensional and price data are provided on these valves used for corrosive gases, liquids and steam up to 450° F.

20. Hydraulic Oils

Denison Engineering Co.—Some of the more important points in a well planned hydraulic preventive maintenance program are outlined in 16-page bulletin 45. Factors governing selection of hydraulic oils, those affecting performance and a procedure to assure suitable oil condition are provided in this well illustrated piece.

21. Load-Bearing Steel Bars

La Salle Steel Co.—Super La-Led load-bearing steel bar stock which can be used to replace brass is briefly described in 4-page folder. Bars will machine over 80 per cent faster than ordinary screw stocks.

22. Butterfly Valves

S. P. Kinney Engineers, Inc.—Six available data bulletins provide descriptive information on fabricated steel and cast iron butterfly valves. Dimensions and pressures are tabulated on these valves used for control of hot or cold gases and liquids.

23. Shock-Absorbing Casters

Bassick Co.—20-page catalog on Floating-Hub shock absorbing casters which will withstand shock of vertical and horizontal impacts describes construction, lists type and mountings and provides load ratings. Range of load capacities run from 50 to 25,000 lb each.

24. Powdered Metal Parts

Chicago Powdered Metal Products Co.—Examples of diversified types of parts which can be produced from powdered metal are found in two 4-page illustrated bulletins. Design suggestions and physical characteristics of brass, bronze and iron materials are included.

25. Fabrication & Machining

Twigg Industries, Inc.—Precision fabrication and machining of stainless steel, aluminum, titanium and other high capacity metals and alloys, the scope of operations of this company, are covered in a 20-page brochure. Company engineering, design and production facilities are detailed.

26. Power Transmission Equipment

Western Gear Works—Plant facilities, engineering, assembly operations, testing and inspection are covered in this 36-page illustrated and plastic-bound bulletin 5400. Standard company products include marine gears, speed reducers, torque converters, gearmotors, agitator drives, printing presses, rotary electric equipment and gears. Other lines include hoists and winches, aircraft actuators, accessory drives, turbine drives and special machinery.

27. Toggle Switches

Minneapolis-Honeywell Regulator Co., Micro Switch Div.—Nineteen precision snap-action toggle switch assemblies and over 90 AN and JAN approved designs for controlling from 1 to 24 separate electrical circuits are found in 12-page illustrated revised catalog No. 73a. Dimensions, operating characteristics, electrical ratings and contact arrangements for each model are given.

28. Friction Material

Raybestos-Manhattan, Inc. — 44-page illustrated plastic-bound engineering bulletin 500 covers brake linings and blocks, clutch facings, friction materials in special shapes and sintered metal friction materials. Information is given on selection of materials for operation in oil and for dry applications. Conditions under which each material will operate are presented.

29. Back Pressure Control Valve

A. W. Cash Valve Mfg. Corp.—Type KD automatic back pressure control valve for use in refrigeration, flooded systems and/or systems employing thermal expansion valves for liquid feed is described and illustrated in 2-page KD bulletin No. 1. Application, operation, construction and installation data are given.

30. Cam Operated Indexing Units

Standard Tool & Mfg. Co.—Automatic cam-operated indexing units for application to assembly equipment and industrial positioning and conveyor control are subject of 4-page bulletin No. 12. Index increments of 8, 12, 16 or 20 can be obtained in a complete revolution. Units with 50 to 90 and 10 to 45 indexes per minute are available.

31. Universal Testing Machines

Baldwin-Lima-Hamilton Corp.—Two Baldwin-Tate-Emery universal testing machines of 20,000 and 60,000-lb capacity are detailed in 4-page illustrated bulletin 4213. Principles of their hydraulic straining system and null method load indicator are given. Specifications are included and accessories are described.

32. Flexible Shafts & Couplings

Kupfrian Mfg. Co.—16 pages of information relating to design and use of flexible shafts and couplings are contained in illustrated catalog 5494. Table of physical properties of 24 different flexible shafts ranging in size from ⅛ to ⅜-in. is included. Also covered are 29 shaft casings, over 30 couplings and assemblies and 100 other components.

33. Chain Sprockets

Cullman Wheel Co.—16-page illustrated catalog 184 covers Gripmaster sprockets, flexible couplings and steel "weld-on" hubs. Interchangeable bushing system is fully explained and general product information and specifications are given.

34. Selecting A Motor Pump

Ingersoll-Rand Co., Cameron Pump Div.—A slidefilm presentation in printed form, 16-page illustrated catalog 7123 deals with selection of the proper motor pump for any specific job. What the centrifugal pump is and how it works, and the various factors which must be considered before purchase are treated.

(Continued on Page 190)

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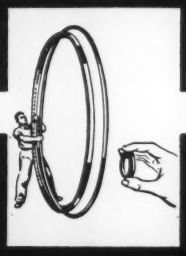

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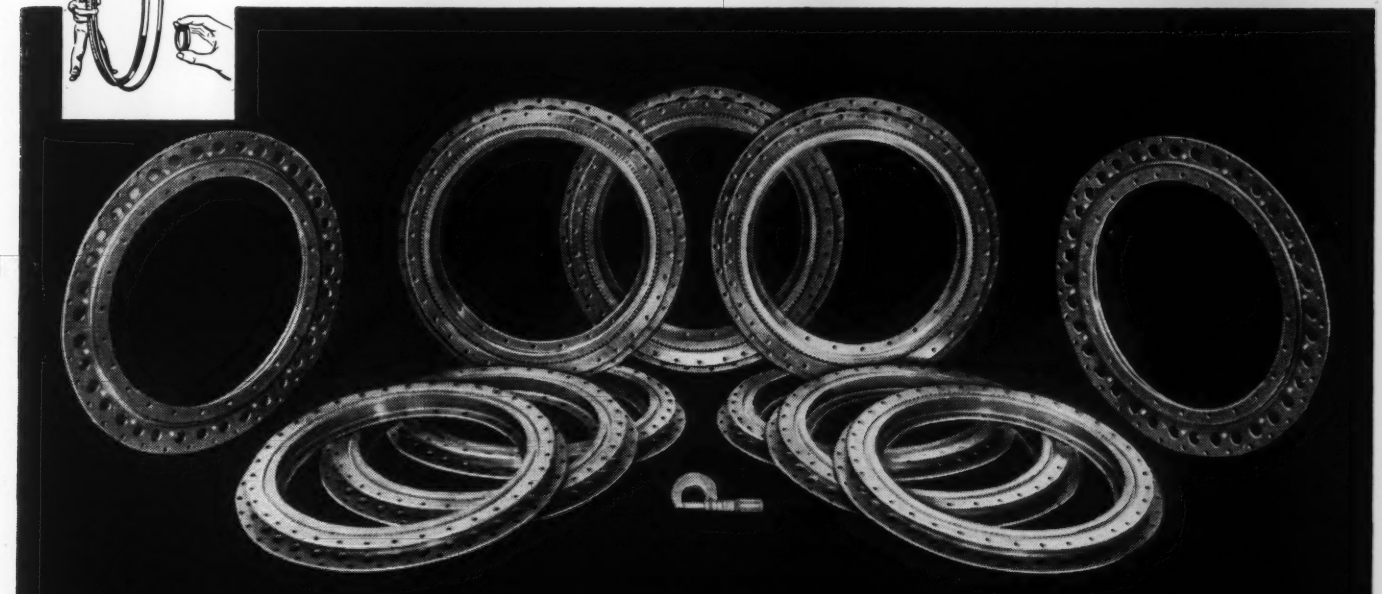
FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



Double-row radial ball bearings
11.375" x 16.000" x 1.062"

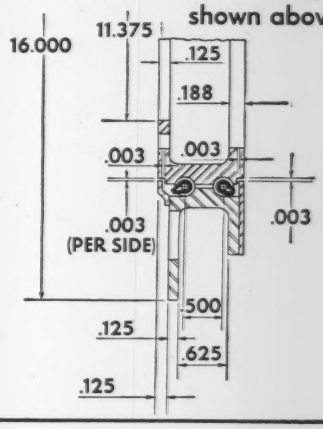
Pattern for precision...and profit

Make it standard procedure to contact Kaydon for special bearings

Ultra-precise, light weight bearings that perform to exceptionally high standards, yet require minimum space, are KAYDON's specialty. Today, KAYDON offers you unmatched experience in the design of special, thin-section and/or high-precision bearings. Then, too, KAYDON has specially developed production facilities to build these bearings... economically ... on either a custom or volume basis.

Follow the lead of many prominent manufacturers—make it standard practice to consult KAYDON of Muskegon on bearing problems. You'll find it pays in terms of time, money and the performance of your product.

Details of thin section bearings shown above—



KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

Helpful Literature

(Continued from Page 188)

35. Multiple V-Belts

Goodyear Tire & Rubber Co.—Engineering and design data on multiple V-belts are found in this brochure. Fundamentals of V-belt design are detailed and specifications and horsepower rating tables are also included, along with selection and installation information.

36. Circuit Controlling Counters

Counter & Control Corp.—34-page illustrated engineering data catalog presents augmented line of Cyclo-Monitor circuit controlling preset counters with automatic reset. Units repeat automatically without losing time or counts between cycles. Three basic models illustrated pick up the count from rotating machine member, an electrical impulse or photoelectric cell. Cycle diagrams and performance ratings are among technical application data given.

37. Tube Fittings

Samuel Moore & Co., Dekoron Products Div. —Brass, aluminum, steel and type 316 stainless steel Dekoron Hi-Duty tube fittings, subject of 2-page illustrated data sheet, withstand vibration and are rapidly installed. Sectional drawings and cut-away views show design.

38. Centrifugal Pumps

Worthington Corp.—Type UNB two-stage centrifugal pumps for working pressures up to 400 psi and capacities up to 1300 gpm are subject of single sheet bulletin. Section drawing shows design features. Dimension charts and table of construction materials are also included.

39. Cam Clutches

Morse Chain Co.—Series 200 Morse cam clutches for indexing, overrunning, and backstop machine drive applications are described in illustrated 4-page bulletin C12-54. Application data, typical installation drawings and specifications for seven models with torque ratings from 10 to 500 ft-lb are given.

40. Universal Joints

Gear Grinding Machine Co.—Uniform flow of power through rolling action is feature of Rzeppa universal joints, described and illustrated in 12-page bulletin. They are made for heavy, medium and light duty applications in many types of equipment. Bell and disk types are described and engineering data are presented.

41. Magnetically Driven Pump

Fostoria Pressed Steel Corp.—Rotating magnetic field drives the Dynapump, a centrifugal unit described and illustrated in 4-page bulletin P-354. Sealed, leakproof unit is made of stainless steel. Bulletin describes characteristics, specifications and performance.

42. Shock & Vibration Isolators

Barry Corp.—Technical and application data on series 670 and 297 Barrymounts for shock and vibration isolation are found in 4-page illustrated bulletin 538. They are intended for application to impacting machines and other heavy rotating and reciprocating machines. Seven load ratings are made. Included are installation procedures, data on dimensions and loads and other information.

43. Silent Chain Drives

Link-Belt Co.—Versatility of silent chain drives which makes them suitable for a broad range of applications is brought out in 88-page illustrated engineering data book 2425. They can operate continuously at high speeds with high efficiency. Pre-engineered drives are covered and entire line has its specifications given. Operational, installation, maintenance and lubrication data are given.

44. Hydraulic Valves

Hydraulic Press Mfg. Co., Hydraulic Power Div.—Model 2000 series threaded directional and functional valves for 2000 psi hydraulic service are covered in 52-page illustrated catalog No. 801. Four-way, two-way, rotary pilot, sequence, pressure reducing, flow control and check type valves are among those covered.

45. Electrical Connectors

DeJur-Amsco Corp.—Series 16 T precision power connectors available with 7, 10, 15, 18 and 20 contacts with turret terminals are covered in illustrated data sheet. In addition to electrical and mechanical ratings, general information is given on construction of these rectangular units, which are available with hoods for cable mounting.

46. Combination Plastic & Steel

Chemical Development Corp.—Used in making drill jigs, fixtures, forming dies and similar products, Devcon plastic steel is described in 4-page illustrated catalog. Compound can be machined by conventional methods after curing. It retains full mass and shape during the curing process. It can be chrome plated.

47. Aircraft Accessories

S. S. White Dental Mfg. Co., Industrial Div.—Mechanical screw jacks, pressure bulkhead fittings and flexible shaft adaptors are among aircraft accessories for use with flexible shafts described and illustrated in 4-page bulletin 5403. Engineering drawings, design data and operating characteristics are considered.

48. Alloy Steel Properties

Empire Steel Castings, Inc.—Designation chart for cast stainless and other alloy steel castings gives specifications, analyses, physical properties and uses of various types. It correlates AISI, ASTM, SAE, ACI and company designations. Known as bulletin 454-S, it also shows principal alloying elements.

49. Calculating Wheel

Meehanite Metal Corp.—Calculating wheel known as "Physical Specification Chart for Engineering Design" provides an aid to designers, engineers and others requiring physical properties of the various Meehanite metals. Separate easily-dialed figures deal with general engineering and heat-corrosion-wear resistant types.

50. Cast Iron & Steel Valves

Atkomatic Valve Co. — Specifications for series 4000 cast iron or steel valves are given on illustrated data sheet 106. Maximum ratings for cast steel type are 1000 psi and 450° F. Wide size range is shown as available.

51. Speed Reducers

Euclid Universal Machine Co.—Catalog No. 254 contains 28 illustrated pages on Universal speed reducers. Single, vertical single and compound reductions designs are included, together with miter types. Catalog gives ordering data and details on construction, ratio choice and other specifications.

52. Invisible Hinges

Soss Mfg. Co.—24-page illustrated catalog No. 12-B covers a wide range of hinges for various types of doors which are designed so as to be invisible when the door is closed. They are available both for heavy steel and wood personnel doors and for metal cabinets of all kinds. Design data and applications are given, together with complete specifications.

53. High Speed Relays

Westinghouse Air Brake Co., Union Switch & Signal Div.—Type KP high speed sensitive relay operates on power from 5 to 150 milliwatts with operating time of from 5 to 15 milliseconds and is also available for pulsing speeds of 60 cycles. Polar rotary type relay can be either plug-connected or panel mounted. Bulletin 1002 describes it in 4 illustrated pages.

54. Liquid & Gas Controls

Simplex Valve & Meter Co.—36-page illustrated general catalog No. 004 deals with equipment for measurement and control of liquids and gases. This includes controllers, gages, manometers, recorders, meters, valves and venturi tubes.

55. Solenoid Valve

Skinner Chuck Co., Electric Valve Div.—Illustrated data sheet No. 530 gives engineering data on type V5-3 three-way normally closed quick exhaust solenoid valve. Supplementary exhaust port is provided to increase operating speed of controlled cylinders. Complete specifications are given.

56. General Purpose Turbines

Westinghouse Electric Corp.—20-page illustrated booklet B-3896 has data on design and construction of type E general purpose turbines, made in ratings through 1500 hp. Applications are discussed and specifications and selection data are provided.

57. V-Belt Capacity Calculator

Allis-Chalmers Mfg. Co.—"Guide for Figuring Texrope Drives" is title of 6-page bulletin 20B6956B which condenses the necessary information on a new method of calculating the horsepower capacity of Texrope v-belt drives. Formula shown provides ratings for both standard and high capacity belts.

58. Contract Screw Machining

Delo-Screw Products Co.—8-page illustrated catalog 100 gives details of facilities for contract screw machining. Quality control, production and toolroom equipment, personnel and past customers are all discussed. Capacity ranges up to 1¼-in. spindle size.

59. Electrical Components

Soreng Products Corp.—Solenoids, automatic and manual switches, timers, heat controls and terminals are among the company products covered in loose-leaf illustrated folder entitled "Research—Design—Production." In addition to specifications, engineering and design data are furnished.

60. Hydraulic Components

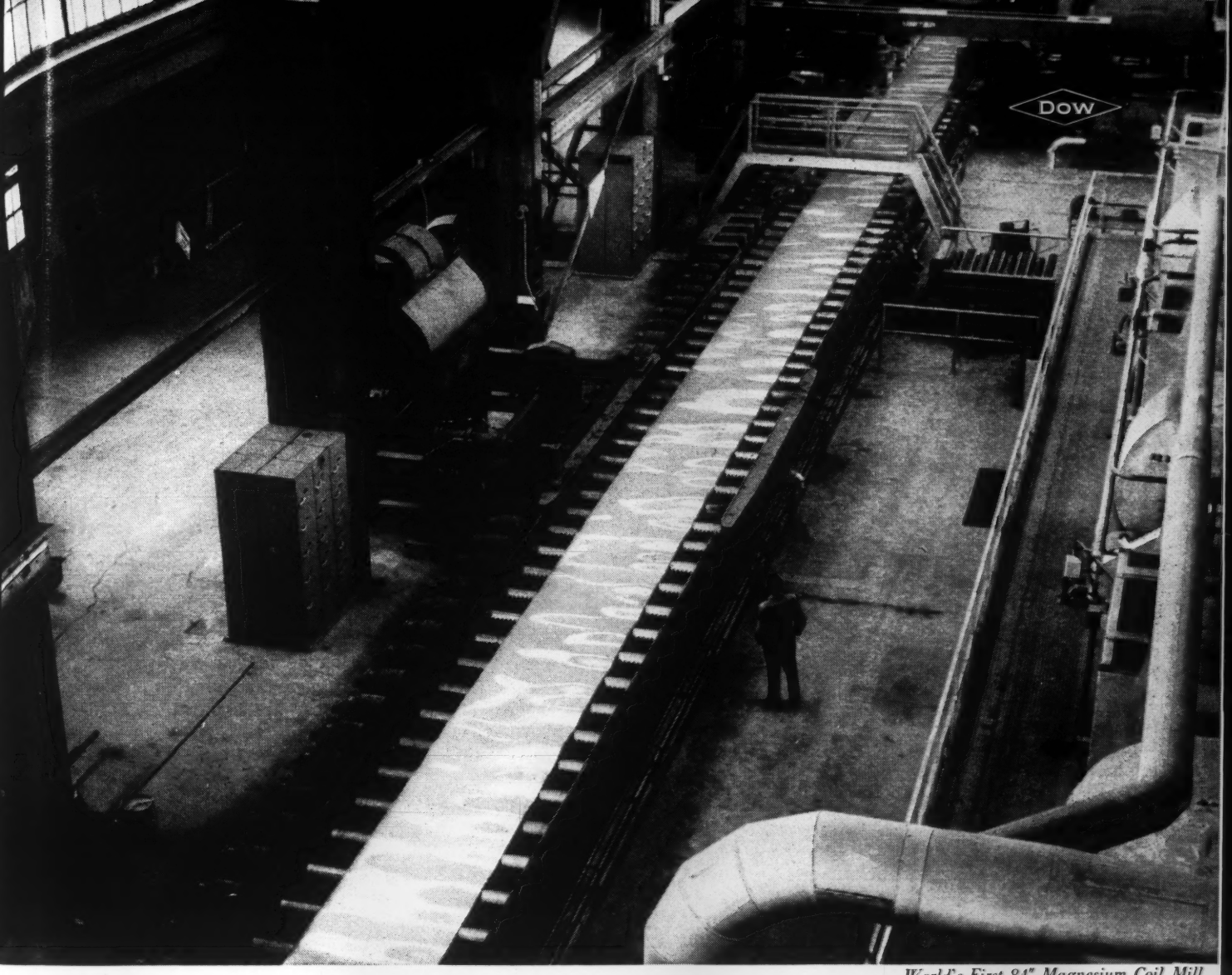
Hydraulic Unit Specialties Co.—Hydraulic control valves, high pressure rotating swivel, single and double acting cylinders, valves, gear pumps and telescopic cylinders are among hydraulic components described and illustrated in series of data sheets. Specifications and applications are given on each product.

61. Industrial Hose & Couplings

Anchor Coupling Co.—Engineering information and design data on a wide variety of industrial hosing, hose fittings and assemblies are given in well-illustrated catalog No. 54. Construction details and valuable application information are given on the various types of hose in its 104 pages.

62. Electrical Components

Electran Mfg. Co.—6-page illustrated bulletin 54X describes such electrical and electronic components as custom-made transformers, reactors, chokes and special windings. Bulletin tells how this company works with you to make parts to your specifications and needs.

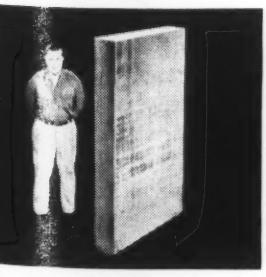


World's First 84" Magnesium Coil Mill.

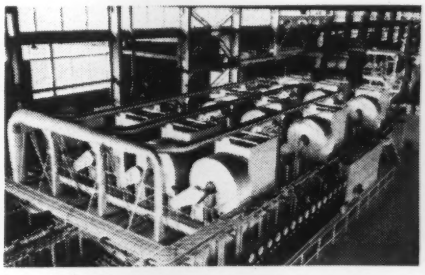
a new look at Magnesium!

UP TO 25% PRICE REDUCTION ON SHEET AND PLATE

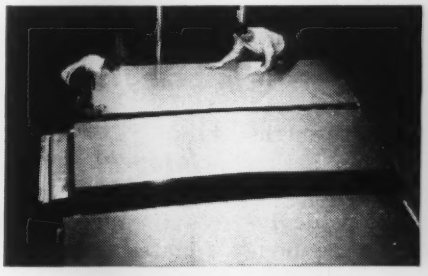
New Dow facilities—now in operation—are producing magnesium sheet in *quantity*. Wider, longer—magnesium sheet now offers a brand new challenge to designers, engineers, manufacturers. To cut costs, to save weight, to add strength—to do revolutionary new things for many products—get the new magnesium story! Call the nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Magnesium Department, Midland, Michigan.



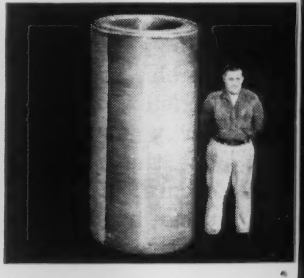
ere for the first time, large agnesium rolling ingots weigh- g nearly a ton are being rolled.



Specially designed, carefully controlled ovens pre-heat huge magnesium ingots just before rolling.



Constant inspection plus rigid production controls assure uniform magnesium sheet quality.



Note how coil of magnesium sheet illustrates new availability in greater widths and lengths.

you can depend on DOW MAGNESIUM

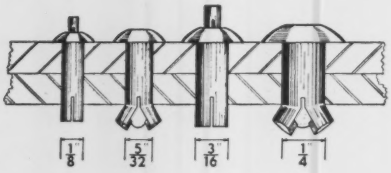
DOW

NEW PARTS AND MATERIALS

For additional information on these new developments, see Page 187

Blind Rivet

Now available in 5/32-in. diameter size, this fastener is installed by striking the pin with a hammer, which expands four prongs to form a second head on the blind end of the rivet. Pulling, exploding and twisting actions, access to rear of work, and finish-

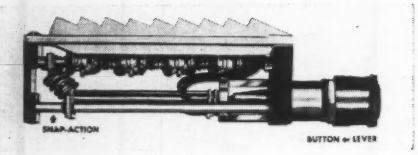


ing operations are not required. Rivet is available in range of grip lengths from 1/32 to 5/8-in. Made by Southco Div., **South Chester Corp.**, Lester, Pa.

For more data circle MD-63, Page 187

Double-Throw Switch

Button or lever actuation of this eight-pole, double-throw switch enables it to switch eight circuits. Constant contact pressure of 4 oz per point is maintained throughout the stroke until snap action occurs in either direction. Contacts handle 5 amp, 28 v dc inductive; 10 amp, 115 v ac noninductive; 60 to 400 cycles. Exceeding military specification ANS-63, switch resists shock and vibration and will operate in range from −65 to 160 F. It is available with auxiliary "push to test"



single-pole, double-throw circuit and dial light and mounts on 1½ x 1¼-in. panel area. Made by **Guardian Electric Mfg. Co.**, 1621-PD W. Walnut St., Chicago 12, Ill.

For more data circle MD-64, Page 187

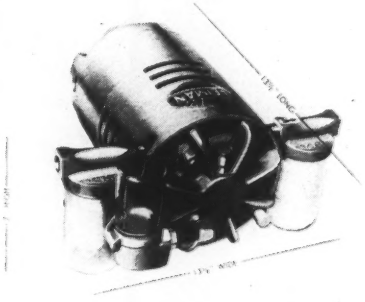
Precision Ground Gaskets

A new process makes possible the precision grinding of cork, rubber, plastic, felt, fiber and paper gaskets. Material thickness accuracy is within 0.003-in. tolerance. Where paper shims are required to eliminate lapping of mating surfaces, shim stock can be ground to within 0.001-in. thickness tolerance. Coated fabric and cloth can be roughened to provide better adhesion and provide uniform thickness. Made by **Welcraft Products Co.**, New Carlisle, Ind.

For more data circle MD-65, Page 187

Integral Pump

Compact design of pump eliminates belts, pulleys, guard and base. The pump produces vacuums up to 28 in. and has 3.6 cfm displacement. It can also be used for pressure. Complete with inlet filter, outlet separator and automatic oiler, fan-cooled pump is equipped with ball bearings and self-lubricating grease cups. Pump blades are automatically forced against cylinder wall by an adjusting device which also prevents sticking of blades. Pump and 1/3-hp motor are separable. Made by



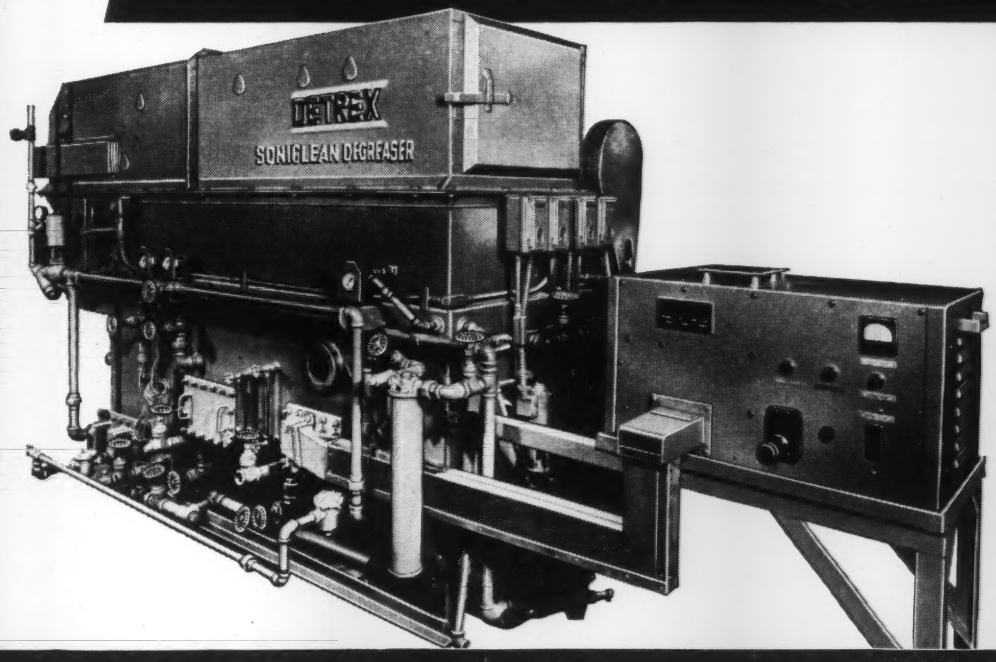
Leiman Bros Inc., 102 Christie St., Newark 5, N. J.

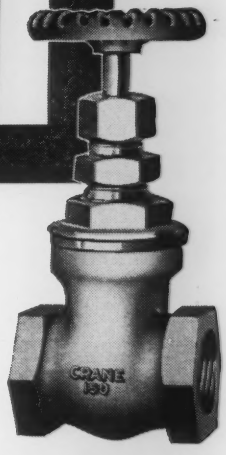
For more data circle MD-66, Page 187

Roller Cam Follower

Principle of Pitchlign bearing is incorporated in roller type cam follower to control position and direction of rollers at their pitch circle. Cage is held firmly in position by two shoulders at either end of the raceway. This support around periphery of cage reinforces it against any torque or wrenching action due to misalignment or irregular cam surfaces. Cage is free-floating axially so that it can float with rollers if thrust forces develop. Rollers are retained in channel raceway, the shoulders of which provide unbroken surface

HOW TO CLEAN WITH ULTRASONIC WAVES





Crane 150-Pound Brass Valve . . . in the new streamlined design. An ideal specification for all "exposed" applications. A highly dependable, tight-seating valve. Cylindrical upper body is same basic shape as high-pressure steel valves for greater strength and rigidity. Has an improved stuffing box that screws *into* the bonnet—also better stem support to assure true alignment and minimize wear on the packing. Sizes ¼ to 3-inch.

another successful product design with piping equipment by CRANE

Solvent—plus sound energy at the rate of 430,000 cycles per second—provides the deep and penetrating cleaning action in this *Soniclean* degreaser by Detrex Corporation of Detroit. Even microscopic soil particles are effectively removed, making it an ideal process for cleaning intricate parts. Source of the sound energy is a special transducer element which overcomes the limitations of quartz crystal previously used for producing ultrasonic waves.

But this new approach to the old problem of cleaning metal still demands the dependability of allied equipment, and for that reason, The Detrex Corporation selects only valves and fittings of known quality. And whether or not your particular design of the moment is concerned with new ways, or an old established method, it always pays to specify Crane. For there's no higher piping quality—no greater valve suitability . . . and no better source of complete specification data.

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CRANE VALVES

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Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

against any thrusting forces. Units can be used with or without inner races. The latter type is available in sizes to fit 0.50 to 2.25-in. shaft diameters. Followers with inner races are offered with inner race ID ranging from 0.50 to 1.75 in. Made by **Roller Bearing Co. of America,** Sullivan Way, W. Trenton, N. J.

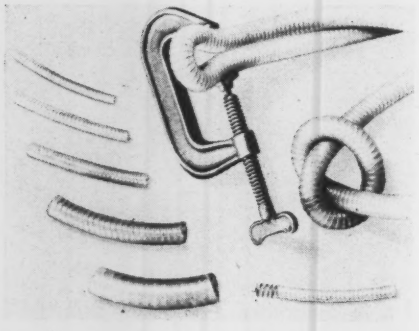
For more data circle MD-67, Page 187

Translucent Plastic Piping

Flexibility and resistance to crushing are provided by Armourvin translucent plastic industrial piping which has 120-ton tensile helical steel wire molded into piping wall. Piping will bend around 5/16-in. diameter spindle without reduction of its internal bore. It resists water, oil, grease, most acids and alkalies, diesel fuel, coal and butane gases and remains flexible at temperatures from −40 to 70 C. Made in one continuous piece, without laminations, in lengths up to 2 miles, it is offered in ⅛ to ½-in. ID and ⅜ to 1-in. OD.

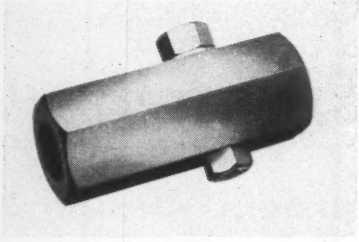
Armorflow piping, which is especially resistant to highly volatile fluids, will handle boiling water without adverse effect. It remains flexible at −40 to 150 C. Made by **Newage International Inc.,** 235 E. 42nd St., New York 17, N. Y.

For more data circle MD-68, Page 187



Flow Control Valve

For service with 150 psi air or 300 psi oil or water, model 3620 valve meters flow in one direction and allows free flow in the opposite direction. It has an anodized aluminum body and a nylon poppet. Corrosion-resistant adjusting screw has a slotted hex head which may be turned with a wrench or screwdriver. Tightening the hex nut on the opposite end of the adjustment screw locks the setting. This ⅜-in. valve is 3 in. long, has a 1⅛-in. hex and weighs 6 oz. Made by **Rivett Lathe & Grinder Inc.,** P. O. Box 7, Brighton 35, Mass.



For more data circle MD-69, Page 187

Limit Switch

Type 101ML1 heavy-duty limit switch has precision two-circuit switching action and is suitable for use under conditions of severe shock and impact. Snap-action spring accomplishes simultaneous make-and-break of both normally-closed and normally-open circuits. Aluminum enclosure is fitted with synthetic rubber gaskets which prevent entrance of moisture or foreign matter. Roller-arm actuator is adjustable in the field to any of four positions at 90-degree intervals. Electrical rating is 10 amp at 110, 220 or 440 v ac, and pilot duty rating is 6 amp at 125 v ac. Contact arrangement is single-pole, double-throw, two-circuit double-break. Made by Micro Switch Div., **Minneapolis-Honeywell Regulator Co.,** Freeport, Ill.

For more data circle MD-70, Page 187

Polystyrene Alloy Sheet

Campco S-300GM rigid polystyrene alloy sheet has an integral high-gloss surface finish which resembles porcelain enamel. It can be fabricated into complex shapes by vacuum forming or similar techniques used to form rigid thermoplastic sheet. The material is available in white in standard size sheets 39 x 72 in., 0.08 and 0.10-in. thick. It can also be supplied 39 in. wide in any desired length and in pastel colors. Applications include housings, refrigerator interior components and splash panels. Made by Campco Div., **Chicago Molded Products Corp.,** 2717 N. Normandy Ave., Chicago 35, Ill.

For more data circle MD-71, Page 187

Concave Nut

Made of hardened and spring-tempered high carbon steel, the P-M nut is self-gripping and self-locking. Lock washers are not needed. Concave fastener has cut threads and a flange with turned-down corners that bite into the material to which it is applied. Spring flange is deflected during tightening so that tension applied

the amazing "lubrication fitting" that thinks ahead...

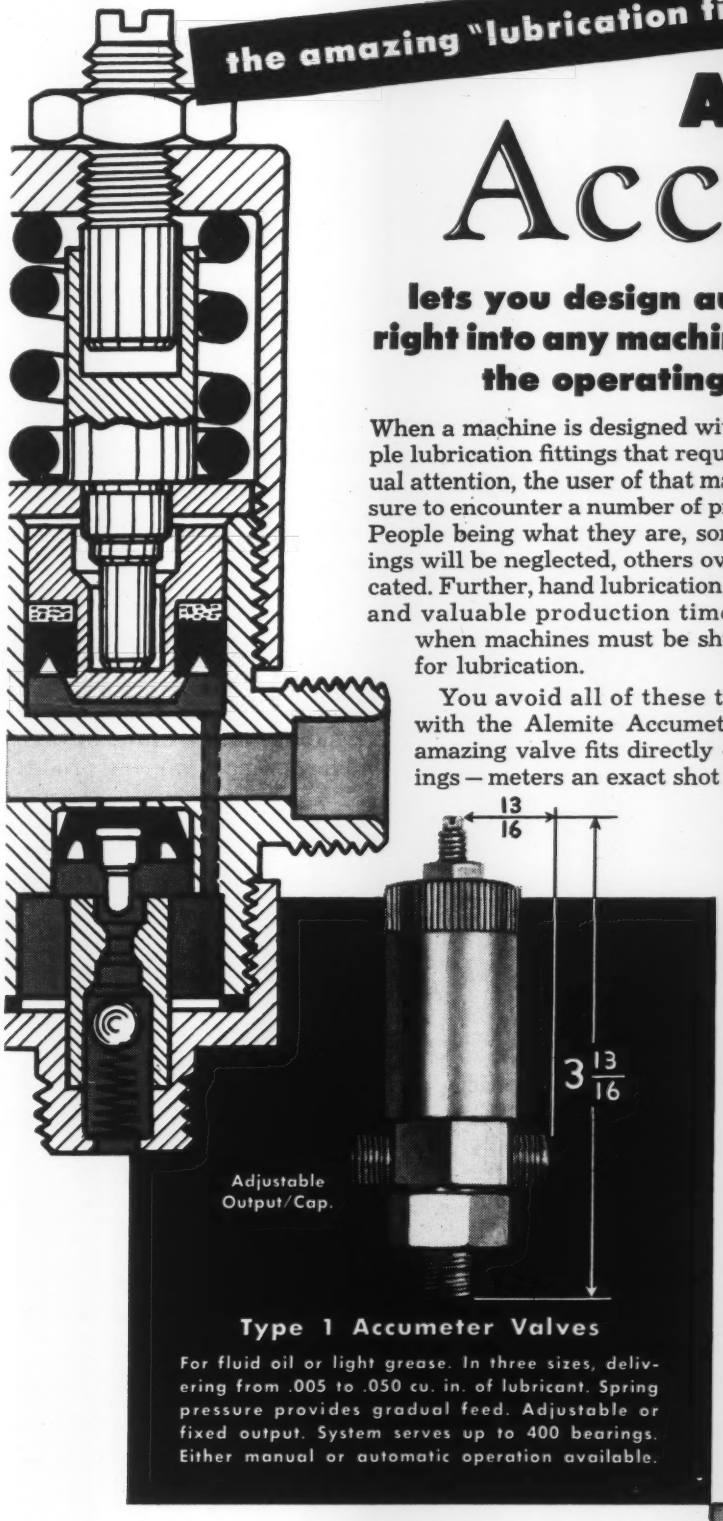
ALEMITE Accumeter®

lets you design automatic, fool-proof lubrication right into any machine—simply, economically...offers the operating savings industry will buy!

When a machine is designed with multiple lubrication fittings that require manual attention, the user of that machine is sure to encounter a number of problems. People being what they are, some bearings will be neglected, others over-lubricated. Further, hand lubrication is costly and valuable production time is lost when machines must be shut down for lubrication.

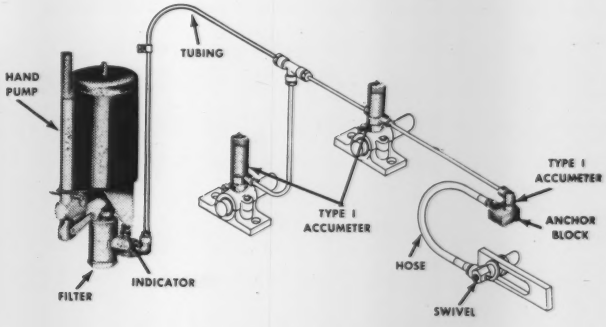
You avoid all of these troubles with the Alemite Accumeter. This amazing valve fits directly on bearings – meters an exact shot of oil or grease *automatically—at pre-determined intervals—while the machine is in operation!* Time, production and maintenance costs are cut to the bone! With all these advantages, it is small wonder that 95% of all major plants buying machine tools specify centralized lubrication.

The Alemite Accumeter system is simple to design and build into any machine. Automatic Accumeter Systems assure you positive, low-cost lubrication. Find out about these automatic systems now. See the savings, the efficiency they add and you too will specify Accumeter!



Type 1 Accumeter Valves

For fluid oil or light grease. In three sizes, delivering from .005 to .050 cu. in. of lubricant. Spring pressure provides gradual feed. Adjustable or fixed output. System serves up to 400 bearings. Either manual or automatic operation available.



offers all these advantages!

- Eliminates shutdown time for lubrication. Adds productive time to machine output
- Seals completely against dirt, grit, water all the way from "Barrel-to-bearing"
- Prevents bearing troubles due to neglect or use of wrong lubricant
- Services all bearings—including those inaccessible or dangerous—in one operation
- Avoids work spoilage and bearing repairs due to over-lubrication

factory tested—field proved

Exhaustive, in-the-field tests show no appreciable variation in the amount of lubricant discharged after 73,312 lubrication cycles—*equal to* 122 YEARS *of twice-a-day service!*

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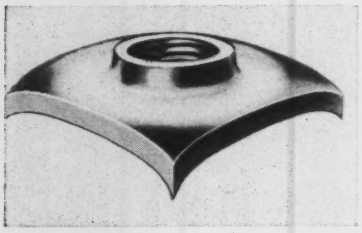
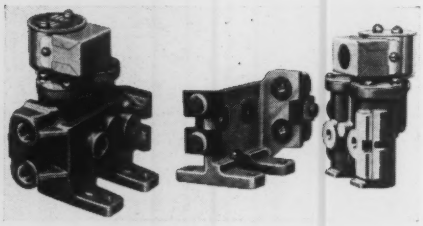


to thread prevents loosening. Nut can be removed and reused, and is currently made in 6-32, 8-32, 10-24 and 10-32 sizes. Made by **Waterbury Pressed Metal Co.,** P-M Nut Div., 300 Chase Ave., Waterbury, Conn.

For more data circle MD-72, Page 187

Four-Way Valves

Air, light oil and water at pressures up to 150 psi can be handled by Crescent pilot-operated, solenoid-controlled four-way valves. They are easily replaced by loosening three holding clamp bolts to remove the entire valve body. Sub-

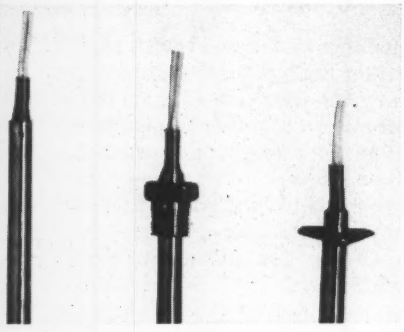


base on which body is mounted remains undisturbed as a permanent part of the piping. Made by **Barksdale Valves,** 5125 Alcoa Ave., Los Angeles 58, Calif.

For more data circle MD-73, Page 187

Miniature Thermostats

Precision two-wire thermostats are ¼-in. in diameter and about 2⅜ in. long. These Thermoswitches can be used, with suitable relay circuit, as temperature controllers in any heated device where installation space is limited. Typical uses are as overheat detectors in high-speed machine bearings, ovens, oil pumps, platens and heater ducts. Unit is stable under shock and continuous vibration and is factory-set to actuate at any selected temperature in the range from −65 to 450 F with an accuracy of 1 to 5 F, depending upon set point. Models with three mounting arrangements are available, all designed for 1-amp service at 115 v ac or 32 v dc. Electrical contacts close when external temperature rises to the actuation temperature. Regular-action models, with con-

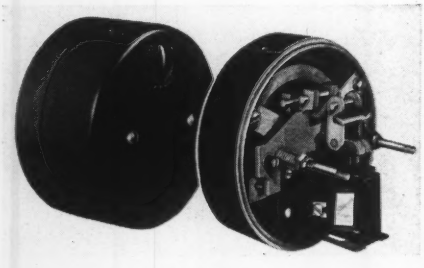


tacts which open on temperature rise, will be available shortly. Made by **Fenwal Inc.,** Pleasant St., Ashland, Mass.

For more data circle MD-74, Page 187

Magnetic Brakes

Line of 40 and 50 series magnetic disk brakes meets rerated NEMA frame standard for 1/20 to 1/3-hp and for 1/6 to 2 hp. Series 40, for the lower ratings, has a torque range from 6 lb-in. to 1 lb-ft. It is designed for mounting on standard NEMA C end bell for motor frames 42-C and 48-C and is also available for independent floor mounting. Series 50 is available in torque ratings of 1½, 3, 6 and 9 lb-ft. It is designed to mount on fractional horsepower frames 56-C and 66-C and integral horse-

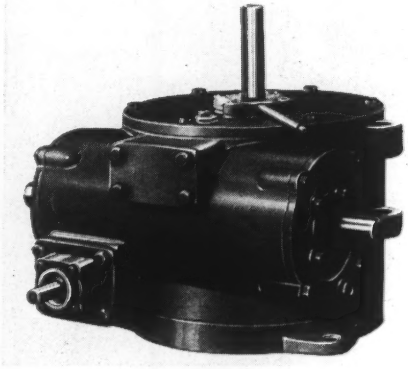


power frames 182 and 184. It requires less than one-half of former mounting space. Made by **Stearns Magnetic Inc.,** 635 S. 28th St., Milwaukee 46, Wis.

For more data circle MD-75, Page 187

Indexing Unit

Automatic cam-operated indexing unit is designed to be built into machine drives to provide either precision positioning for production stations or a simplified timing method. Increments of either 8, 12, 16 or 20 indexes can be obtained during any cycle. All rotating shafts are mounted on tapered roller bearings for accuracy. Camshaft extensions provide a means for operating auxiliary drives or other production devices. Unit measures 17 in. long, 16½-in. wide and 13¾-in. high overall. It can be supplied with different drive assemblies to meet varying produc-



tion requirements. Made by **Standard Tool & Mfg. Co.,** 740 Schuyler Ave., Lyndhurst, N. J.

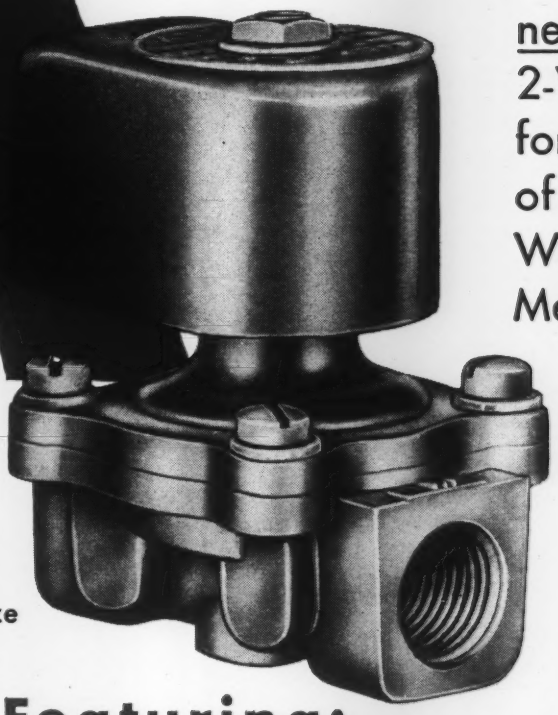
For more data circle MD-76, Page 187

Miniature Motors

Available in either two or four-pole synchronous or induction types in ratings of 1/2000, 1/1500, 1/1000 or 1/750-hp, with power dissipated within safe temperature rise, series 1001 through 1008 totally enclosed Borg-Motors employ precision machined die-cast alloys for end bells and gear train cases. Any model can be supplied with or

Announcing

new ASCO®
2-Way Solenoid Valve
for controlling the flow
of Air, Gas, Light Oil,
Water, Brine, Freon,
Methyl Chloride, etc.



BULLETIN 8210A
SOLENOID VALVE
shown approximate size

Pipe sizes—
3/8" and 1/2"

Maximum pressure—
Air—200 p. s. i.

Featuring:

- **Compactness** — 2¾" Face to Face.
  3¼" Pipe center line to top of Solenoid.
  3 13/16" Overall Height.
- **Simplicity** — Only two operating parts: flexible diaphragm and stainless steel core.
- **Ruggedness** — Designed for millions of maintenance free operations.
- **Forged Brass Body and Bonnet** insure freedom from porosity.
- **No Corrosion Problems** — All parts in contact with fluids are of brass or stainless steel.
- **Normally Open or Normally Closed** Types Available.
- **Low Power Consumption** — Only 10 Watts!
- **No Jamming or Binding** — No closely fitted parts that can be jammed by solid matter.
- **Nema I Standard or Nema VII** Explosion-Proof Solenoid enclosures.
- **Over Two Years** under Development and Life Test!

THIS NEW BULLETIN 8210A SOLENOID VALVE IS ONE OF THOUSANDS OF TYPES & SIZES IN OUR STANDARD LINE.

WRITE FOR COMPLETE INFORMATION
We design and manufacture a complete line of Solenoid Valves and Electromagnetic Controls including Automatic Transfer Switches, Remote Control Switches, Contactors, Relays, and Complete Control Panels.

ASCO Solenoid VALVES

Automatic Switch Co.

387 LAKESIDE AVENUE · ORANGE, NEW JERSEY

without an internal gear train. Standard units operate on 115-v, 60-cycle current; special voltages and frequencies are available. Made by **George W. Borg Corp.**, 120 S. Main St., Janesville, Wis.

For more data circle MD-77, Page 187

Epoxy Resin

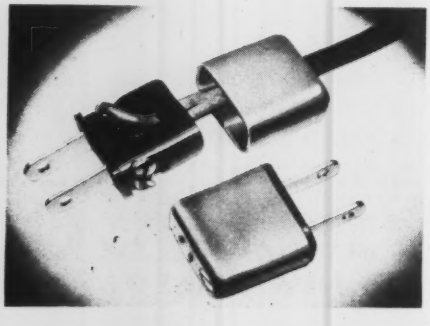
Epocast III, for use in casting, potting and laminating, does not require toxic hardeners and has good cured heat resistance. It is cured in one to three hours at temperatures in the range of 150 to 200 F. An unfilled, transparent resin with a yellow cast, it can be blended with large volumes of fillers to produce transparent colors. Shrinkage is less than 1 per cent. Electrical and physical properties, heat and water resistance are good. Made by **Furane Plastics Inc.**, 4516 Brazil St., Los Angeles 39, Calif.

For more data circle MD-78, Page 187

Line Cord Plug

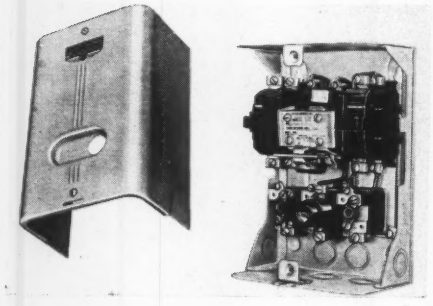
Designated Cat. No. 1420, this plug is fabricated from break-resistant nylon and has molded-in strain relief for line cord. It is approximately two-thirds the size of conventional plugs. Nylon housing is available in a wide variety of colors. Made by **Industrial Devices Inc.**, Edgewater, N. J.

For more data circle MD-79, Page 187



Overload Starter

Three-coil overload starter provides motor protection within 3 per cent of usable motor load. Unit is furnished in the same enclosure as

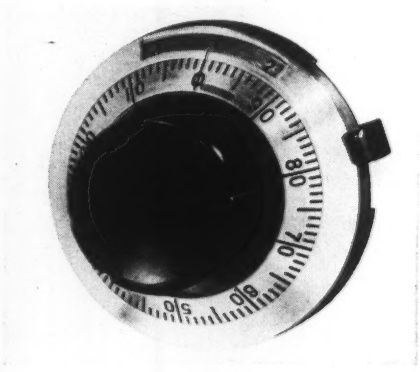


a two-coil unit and is equipped with an adjustable heater coil which provides four different ratings from a single coil by changing its position. Made by **Cutler-Hammer Inc.**, 315 N. Twelfth St., Milwaukee 1, Wis.

For more data circle MD-80, Page 187

Counting Dial

RB series Duodial, used in electrical, mechanical, hydraulic and pneumatic equipment, counts the turns of a rotating component. Unit consists of two coaxial dials and a nylon knob integral with the inner dial, which is calibrated to count hundredths of a turn. The outer dial is calibrated to count 15 complete turns. Since the knob and inner dial are fastened directly on the shaft of the rotating component, critical readings of the inner dial are free from backlash. Rotated by either knob or shaft, device can be used to count power-driven turns as well as to set to a desired value. Set of intermittent gears between inner and outer dials reduces torque and provides easy reading. Models are available to

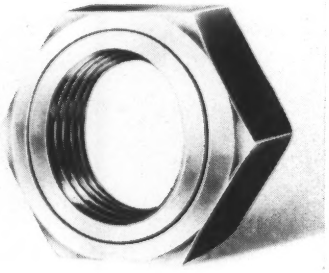


fit ¼ and ⅛-in. diameter shafts. Made by **Helipot Corp.**, 916 Meridian Ave., South Pasadena, Calif.

For more data circle MD-81, Page 187

Machine Screw Nuts

Completely self-locking, these machine screw nuts are double chamfered and countersunk and can be assembled either side up for automatic hopper assembly. They are made in one piece and are not affected by oil or water. Locking action is maintained after repeated use, and nuts will



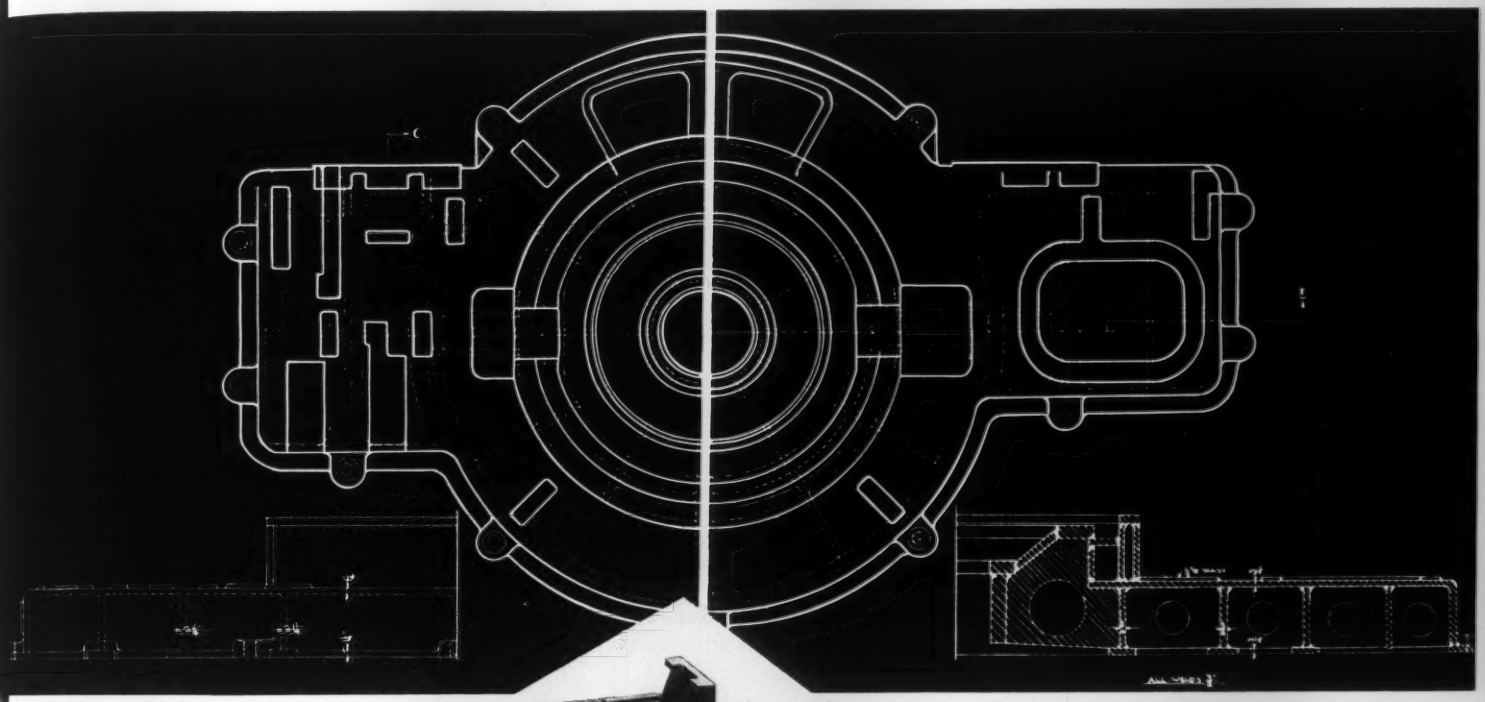
lock in any position on thread. Cold formed for uniformity and strength, nuts are available in steel, brass and aluminum in all machine screw sizes. Made by **Jacobson Mfg. Co. Inc.**, Kenilworth 9, N. J.

For more data circle MD-82, Page 187

Pillow Blocks

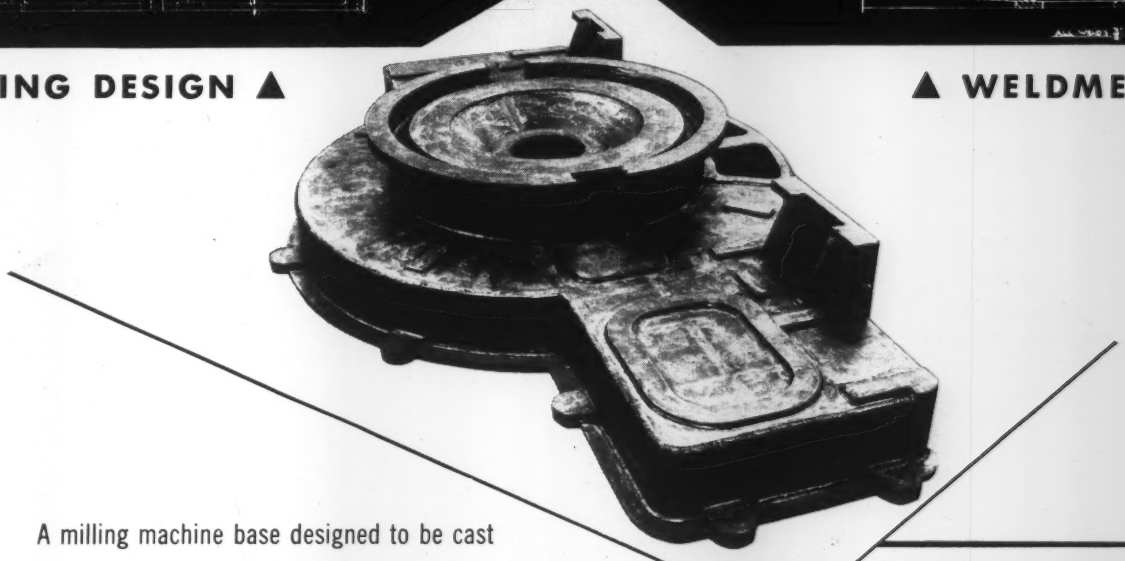
Available for shafts with ⅝ to 1¼-in. diameter, series JPS-200 ball bearing pillow blocks have pressed steel housings. Speed range is 0-1200 rpm. In the ⅝-in. shaft

Conversion to a Steel Weldment = $ $ $ $ $ SAVED



CASTING DESIGN ▲

▲ WELDMENT DESIGN



A milling machine base designed to be cast of gray iron. We took the casting prints, re-designed the base for steel fabrication and the result was a 30% weight reduction on a base whose overall dimensions were 15′ 2″ long x 8′ 9″ wide, at a cost that wasn't much more than the contemplated investment in patterns alone!

If you have a heavy base or a part now on the drawing boards, check with Republic Structural before you decide how it is to be produced and who will do it— we believe we'll save you money!

1,000 TON capacity Hydraulic PRESS BRAKE

★ The largest hydraulic bending and forming installation available.

★ Bends and forms 1″ plate up to 18′ long—straightens 6″ plate up to 18′ long.

The base was, in part, produced on our Press Brake. Welding time and labor was cut — the milling machine will be stronger and lighter.

Republic Structural Iron Works

Division of

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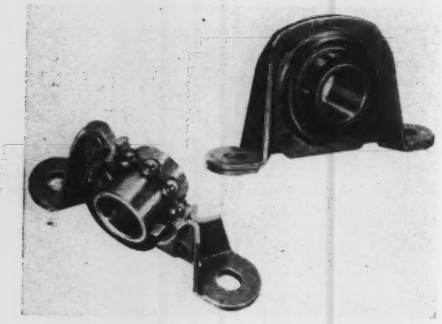
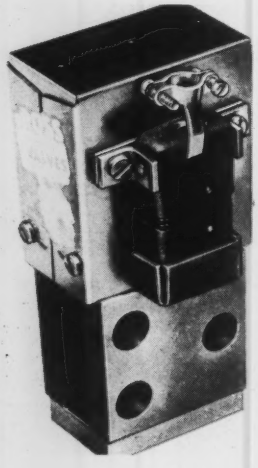


size, radial load ranges from 530 to 160 lb at 33⅓ to 1200 rpm. Single row bearing is self-aligning and retains full load capacity under minor shaft deflection or misalignment. Long inner ring distributes load evenly over a large shaft area. Bearings are lifetime lubricated and have integral synthetic rubber lip type seals. Sizes range from $4\frac{5}{8}$ x $1\frac{3}{32}$ x $2\frac{11}{32}$-in. high to $6\frac{5}{16}$ x $1\frac{9}{16}$ x $3\frac{5}{16}$-in. high. Made by **Link-Belt Co.**, 307 N. Michigan Ave., Chicago 1, Ill.

For more data circle MD-83, Page 187

Air Control Valve

Comet four-way, two-position direct solenoid operated air valve, measuring 5 x 2¼ x 2 in., operates at 800 or more cycles per minute. Valve has only one moving part and is available in manifold, subbase, plate mounting and inline

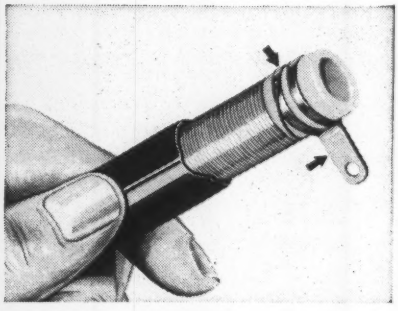


pipe-tapped body types. It can be converted to straightway or three-way operation by plugging some of the ports. Pressure rating is 250 psi on air; maximum operating temperature is 180 F. Made by **Ross Operating Valve Co.**, 120 E. Golden Gate Ave., Detroit 3, Mich.

For more data circle MD-84, Page 187

Wire-Wound Resistors

Entire line of wire-wound resistors is made with the resistance wire welded to the terminal band and the band itself held permanently around the core by means of welding. Permanent connections are not affected by vibration or high temperatures. The stable electrical connection eliminates noise in audio circuits and instability in other sensitive circuits. Terminal bands are made of a high strength alloy whose coefficient of expansion is properly related to that of the resistance wire, ceramic core and vitreous enamel coating.

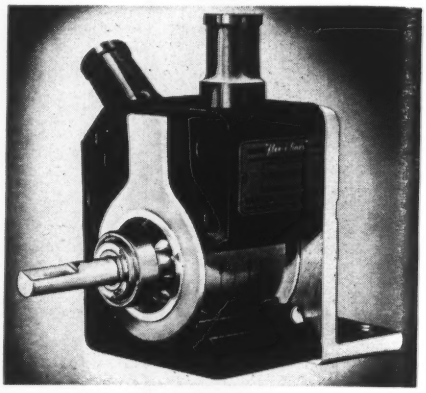


Made by **Ohmite Mfg. Co.**, 3601 Howard St., Skokie, Ill.

For more data circle MD-85, Page 187

Corrosion-Resistant Pumps

Capacities ranging from ⅓ to 20 gpm with pressures up to 60 psi and vacuums to 26 in. of mercury are obtained by V series of Flex-i-liner pumps suitable for service under corrosive conditions. Unplasticized rigid polyvinyl chloride pump block is unaffected by most acids, alkalies, salts, oxidizing agents, oils, greases and alcohols. It is also odorless, tasteless and generally inert. Pumps are self-priming, and fluid contact is restricted to inner surface of block and outer surface of liner. Liner is

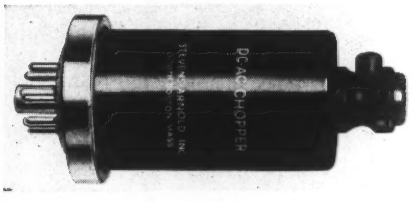


also available made of polyvinyl chloride. Made by **Vanton Pump & Equipment Corp.**, Empire State Bldg., New York 1, N. Y.

For more data circle MD-86, Page 187

DC-AC Choppers

Twenty-two different models are offered in line of 60-cycle, dc-ac choppers for low level operation at noise levels under 1 mv. They are made in single-pole and double-pole types. Make-before-break and break-before-make models are available with gold-alloy or platinum rhodium contacts, removable cover or hermetically sealed container and base or base and top connections. Frequency range is 55 to 65 cycles per second; temperature range, 0 to 43 C or more; coil voltage, 6.3 v; coil current, 90



ma maximum; and coil resistance, 77 ohms ±10 per cent. Made by **Stevens-Arnold, Inc.**, 22 Elkins St., South Boston 27, Mass.

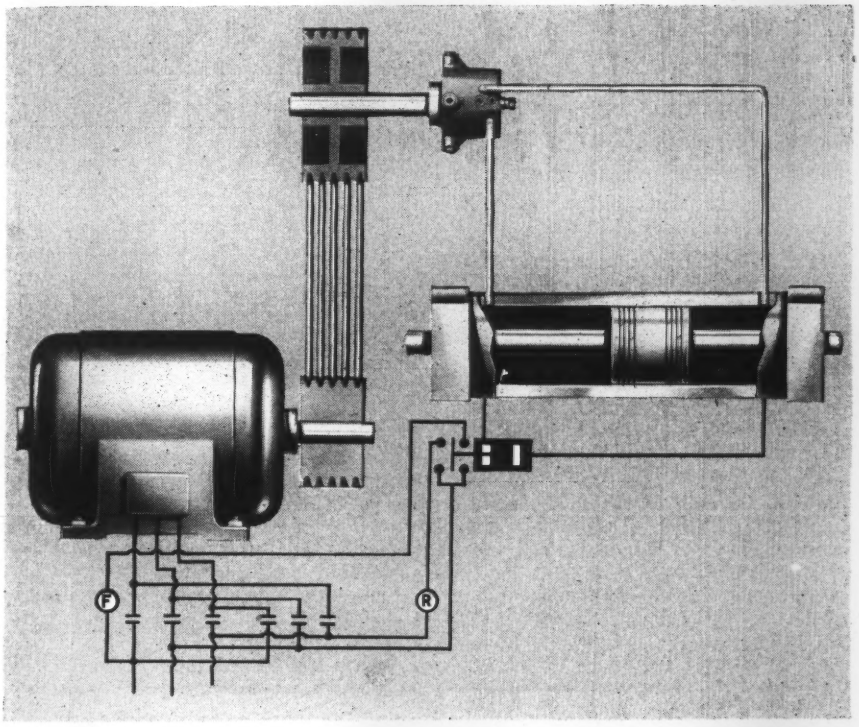
For more data circle MD-87, Page 187

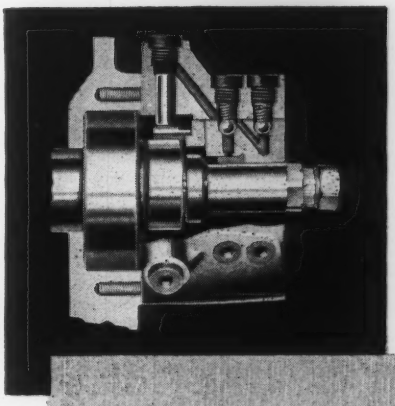
Plastic Wheel

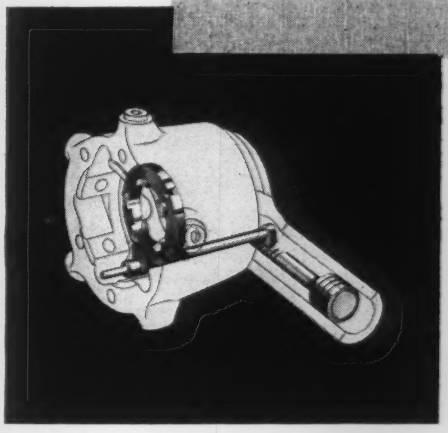
One-piece plastic wheels designed for 6 x 1.50 semipneumatic tires are used on low-speed mobile

alone

BARNES closed variable flow fluid circuit and controls







Fluid power circuit associated with automatic driving arrangement including a rotary drive shaft; bearings for supporting the drive shaft; a variable flow displacement plunger pump driven by the drive shaft; and an adjustment mechanism associated with the drive shaft including control elements adapted to modulate the fluid flow to an actuator.

Result positive control of the actuator speed, gaged control of change in actuator speed, and a specific and predetermined amount of travel of the actuator for each revolution of the pump drive shaft irrespective of the amount of resistance encountered by the actuator.

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870 Ottawa Street
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W. H. Del Mar Co.,
3931 W. Slawson Ave.
Los Angeles 43, California

BRANCH OFFICES

503 New Center Building
Detroit 2, Michigan

3254 Lincoln Avenue
Chicago 13, Illinois

132 East Hanover Street
Trenton 8, New Jersey

JOHN S. BARNES CORPORATION / ROCKFORD, ILLINOIS

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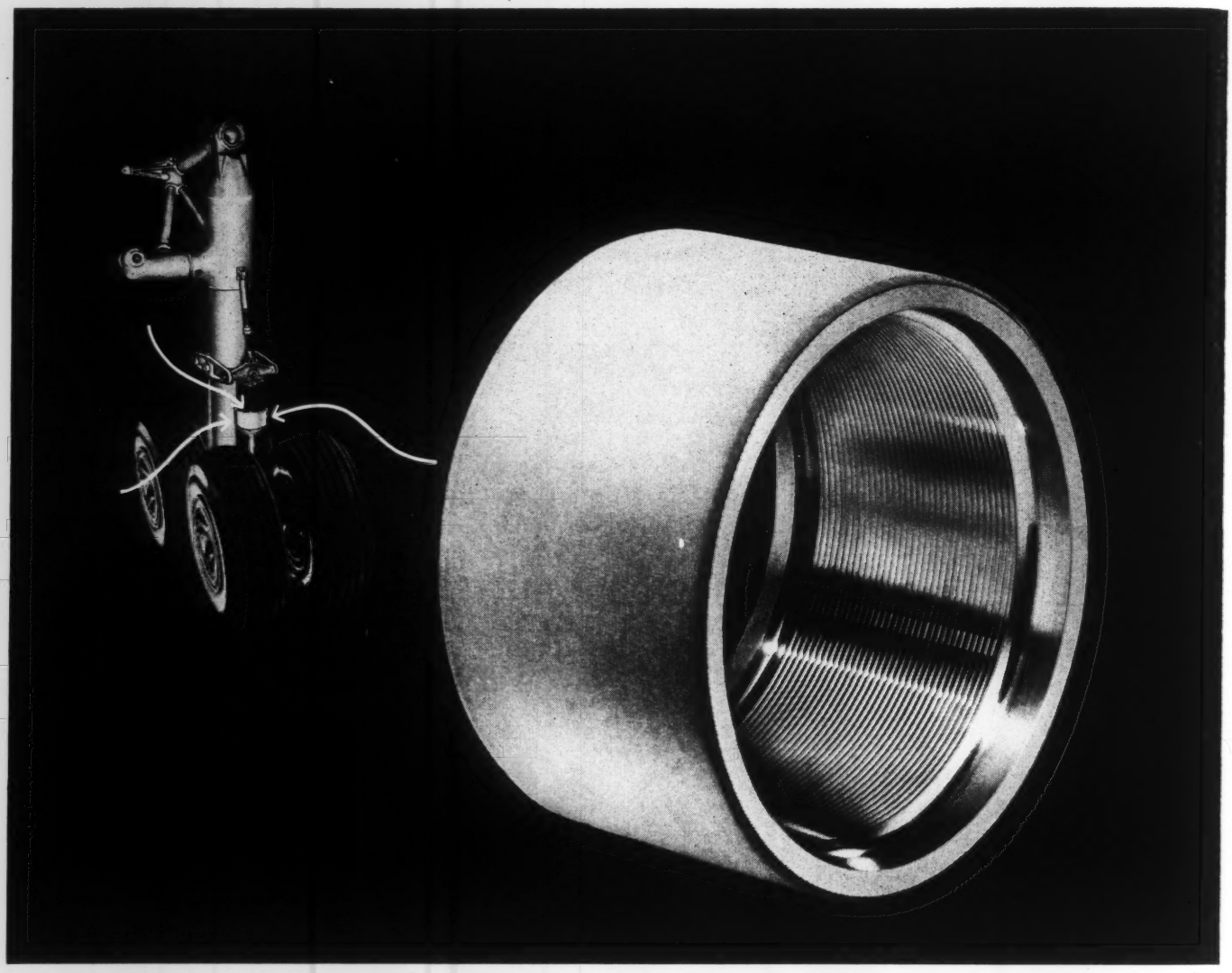
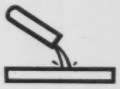


Final Approach to an Easy Touch-Down

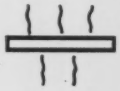
Properties of Synthane

In addition to those mentioned in the text, Synthane has the following important properties:



Chemical resistance. *Synthane* resists most acids and alkalis in moderate concentrations. It is also resistant to corrosive atmospheres.

Low moisture absorption. Most grades of *Synthane* are highly moisture resistant. Special grades are available for applications where absorption must be at a minimum.



Thermosetting. *Synthane* will hold its shape under elevated temperatures. It cannot be reheated and reshaped; once formed it is permanent. (If post-forming is essential, special grades are available.)

Availability. In addition to more than 33 grades of sheets, *Synthane* is also supplied in many grades of rods, tubes and special shapes. Molded-laminated and molded-macerated parts are also manufactured. A complete fabricating service is available.

● A major problem in aircraft design since the very beginning has been proper landing gear. The Wright brothers used rigid, sled-like runners. For many years shock cord—giant-sized rubber bands—took up the load. As planes grew larger and landing speeds climbed, the modern air-oil shock strut was developed. An important component in the largest landing gear struts now made is *Synthane*—a laminated plastic.

The pistons used in shock struts must be tough, mechanically strong, shock-resistant, machinable, light in weight, impervious to oil, long-wearing and non-scoring. They must bond securely to aluminum cores. Dimensional stability is necessary over a wide range of operating temperatures. *Synthane* supplies all of these needed properties.

There are hundreds of applications for *Synthane's* electrical, chemical and mechanical properties. More than 33 different grades of this versatile laminated plastic help to fulfil a variety of specifications. If you have need of a material with many different properties in combination, *Synthane* may be your answer. Our catalog supplies full information about *Synthane* sheets, rods, tubes, and fabricated parts. To get your copy, please write us. Synthane Corporation, 5 River Road, Oaks, Pennsylvania

Our 25th Year

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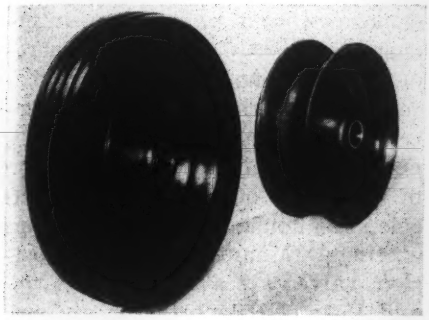
SYNTHANE

LAMINATED S PLASTICS



equipment. Molded of Kralastic material without sharp edges that might damage tires when being mounted, wheels are available in eleven standard colors. Bore size on hub is ½-in., either with or without bronze bearing, and bore lengths of 1⅜ or 1½ in. are made. Made by **Northwest Plastics, Inc.**, Dept. KP, 65 Plato Ave., St. Paul, Minn.

For more data circle MD-88, Page 187

Synthetic Rubber Compound

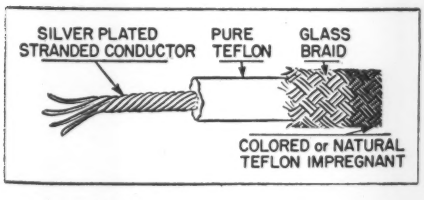
Synthetic rubber compound No. 1120 is suitable for use in O-rings to seal aviation type fuels under pressure conditions up to 1500 psi over a temperature range of approximately −65 to 160 F. Material has high low-temperature flexibility and rapidly recovers from a shrunken condition to one of positive compression in nonaromatic fuel. It does not stick, stain or pit metal. Volume change is moderate in isooctane but high in aromatic fuels. In flushing fluids, such as MIL-0-6081 volume change is ±5 per cent. Made by **Goshen Rubber Co. Inc.**, Goshen, Ind.

For more data circle MD-89, Page 187

Glass-Braided Lead Wire

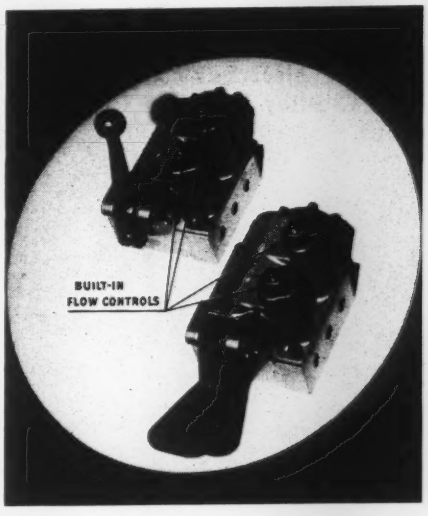
Tempclad lead wire can be used for electronic and electrical components which operate at temperatures from −55 to 200 C. Primary conductor insulation is Teflon; secondary insulation is Teflon-impregnated glass braid. Stranded wire is suitable for use with equipment working at ac potentials to 600 v rms, in severe applications. It is made in sizes 28 AWG through 10 AWG in eight solid colors, with special tracer colors available. Made by **Hitemp Wires Inc.**, 26 Windsor Ave., Mineola, L. I., N. Y.

For more data circle MD-90, Page 187



Four-Way Valve

Hand and foot-operated four-way valve has built-in full-capacity Venturi type flow control meters



and controls double-acting air or hydraulic cylinders. The valve's one balanced spool uses renewable O-ring packing. Basic valve is available for remote pilot operation, cam, single or double solenoid, together with time-delay features. Pipe sizes of ¼, ⅜, ½ and ¾-in. are offered for 0-150 psi range. Made by **Airmatic Valve Inc.**, 7317 Associate Ave., Cleveland 9, O.

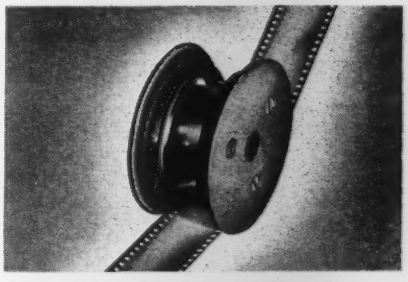
For more data circle MD-91, Page 187

Ball-End Connecting Rods

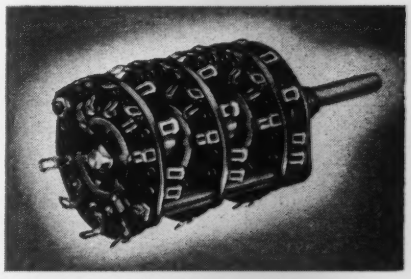
Precision built ball and socket type connecting rods for machinery linkage or butane and gasoline engine carburetors are available in sets and have both left and right-

SYNTHANE

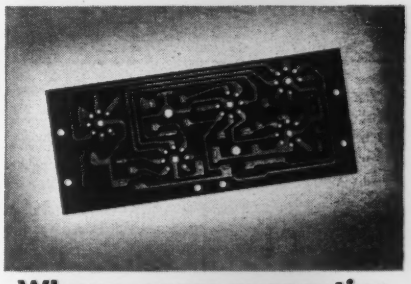
laminated plastics at work



In chemical applications
Synthane's chemical-resistant properties, smooth surface, and durability are valuable to the photographic industry. Synthane components are used in preparing and developing sensitive films.



In electrical applications
Numerous insulating parts made of Synthane are used in radio and TV sets. Synthane supplies dielectric strength, the ability to resist elevated temperatures and excellent insulation resistance.



Where many properties are needed Synthane is a favored base material for printed circuits. It has chemical resistance to resist etching acids, dielectric strength, dimensional stability and it bonds securely with copper foil.

What's your PROBLEM?

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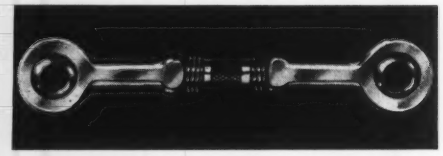
Bakelite Div., Union Carbide and Carbon Corp.	General American Transportation Corp.
Bolta Products Sales, Inc.	General Electric Company
Cast Optics Corp.	Koppers Company, Inc.
Continental-Diamond Fibre Co.	Mica Insulator Co.
Dow Chemical Co.	National Vulcanized Fibre Co.
du Pont de Nemours, E. I., & Co., Inc. Polychemicals Div.	Plexiglas Div., Rohm & Haas Co.
Durez Plastics and Chemicals, Inc.	Regal Plastics Co.
Farley & Loetscher Mfg. Co.	Synthane Corp.
	U. S. Rubber Company
	Westinghouse Electric Corp.

In other sections of the File you will find additional catalogs containing useful information on product forms, characteristics, performance and use.

Sweet's Catalog Service

Division of
F. W. Dodge Corporation
119 West 40th Street, New York 18, N. Y.

New Parts and Materials

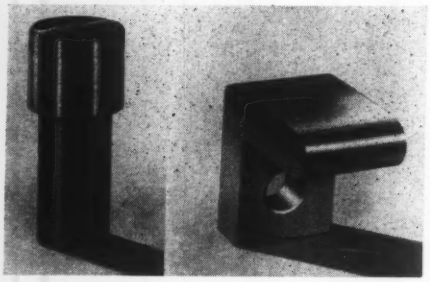


hand threads. They have spring lock adjustments or lock nuts. Bolt hole sizes range from 3/16 through 5/16-in., while variety of lengths from 2⅞-in. bolt center and up can be obtained. Made by **Avalon Machine Products Inc.,** 2535 E. Imperial Hiway, Los Angeles 59, Calif.

For more data circle MD-92, Page 187

Electrical Contacts

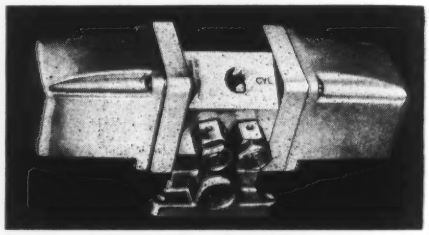
High electrical conductivity and mechanical strength are characteristics of electrical contacts faced with Gibsiloy UC-5 and UC-7, copper-graphite materials made by powder metallurgy. Heavy currents can be handled without contacts sticking. Materials have self-lubricating properties and freedom from galling and excessive wear under extreme use. Made by **Gibson Electric Co.,** 8355 Frankstown Ave., Pittsburgh 21, Pa.



For more data circle MD-93, Page 187

Air and Hydraulic Valves

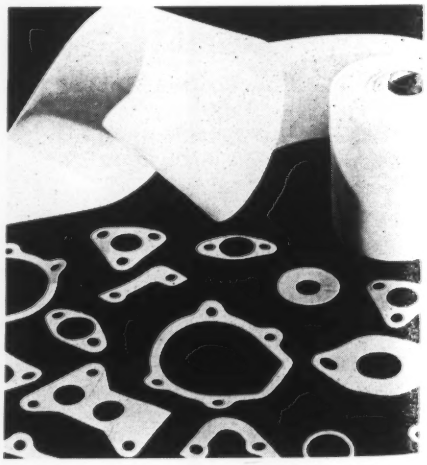
Industrial type, heavy-duty solenoids are embodied in improved Hi-Cyclic single and double solenoid air and hydraulic valves. Other improvements include nylon end-thrust bushings for positive valve piston location; elimination of need for solenoid adjustment; dust and moistureproof solenoid enclosure; and valve part interchangeability. Design permits removal of solenoid coil without disturbing electrical current. Electrical leads are channeled from one ½-in. conduit located at base of valve. Both valve base and solenoid housings are aluminum castings. Mountable in any position, valves are available in ¼, ⅜ and ½-in. NPT ports for air and ⅜-in. NPT ports for hydraulic medium. Sizes up to and including 1 in. will be available. Made by **Beckett-Harcum Co.,** 1087 Wayne Rd., Wilmington, O.



For more data circle MD-94, Page 187

Synthetic Tape

Strength, good electric properties and resistance to abrasion and corrosive chemicals at high and low temperatures are features of Kelon-T nonadhesive chemically inert tape. Made of Teflon tetrafluorethylene resin, it can be used where temperatures from −110 to 300 F exist. It is available in widths up to 12 in., with thicknesses vary-



(*Continued on Page* 213)

(*Continued from Page 204*)

ing from 0.002 to 0.125-in. Made by **W. S. Shamban & Co.**, Dept. O, 11617 W. Jefferson Blvd., Culver City, Calif.

For more data circle MD-95, Page 187

Shim Stock

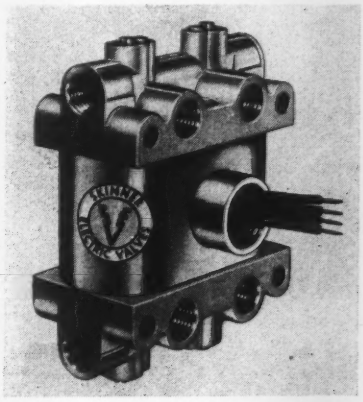
Shim stock is made of aluminum laminations which are bonded over the entire surface. Laminations will peel for adjustment of shim thickness. Material is light in weight and corrosion and

electrolytic-action resistant. It is available either custom stamped to blueprint specifications or as laminated sheet stock in thicknesses from 0.015 to 0.125-in. and in sizes to 20 x 48 in. Made by **Laminated Shim Co.**, Union St., Glenbrook, Conn.

For more data circle MD-96, Page 187

Small Solenoid Valves

Normally open, normally closed or combination normally open and normally closed types are offered in the V9 series of four-way solenoid valves. Measuring 4 5/16 in. high, units are leakproof, suitable for air, hydraulic oils and other common media, and will operate in any position. Valves are made in 176 standard variations of capacities, metering and types. Packless units have die-cast zinc bodies, stainless steel internal parts and varnish impregnated NEMA class coils. Pressures range from 0 to 150 psi and orifice diameters from 3/64 to ⅛-in. Pipe connections have ¼-in. NPT. Valves are available for all com-

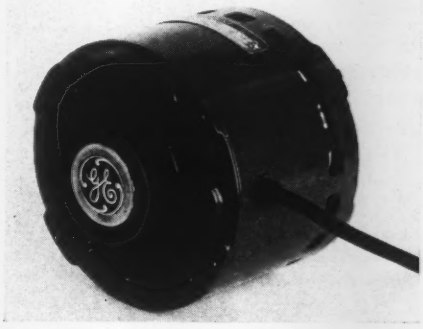


mon alternating and direct current voltages. Made by Skinner Electric Valve Div., **Skinner Chuck Co.**, 95 Edgewood Ave., New Britain, Conn.

For more data circle MD-97, Page 187

Heavy-Duty Motor

Type KSP-39 shaded-pole motor, available in ratings of 1/12, 1/10, ⅛ and 1/6-hp, measures 5½ in. in diameter. It is designed for heavy duty at low input current. Optional characteristics include internal baffling, single and double shaft arrangements, and resilient-



base, cushion-ring or shaft-end mounting. Made by Specialty Component Motor Dept., **General Electric Co.**, Schenectady 5, N. Y.

For more data circle MD-98, Page 187

Subminiature Relay

Designated Class 33, this subminiature dc relay operates in limited space. An open type model with double-pole, double-throw

EXCELLENT DURABILITY • CONSTANT COEFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE — EVEN WHERE OIL SOLIDIFIES OR CARBONIZES • OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE OR OTHER LIQUIDS • EXCELLENT FOR CURRENT-CARRYING BEARINGS

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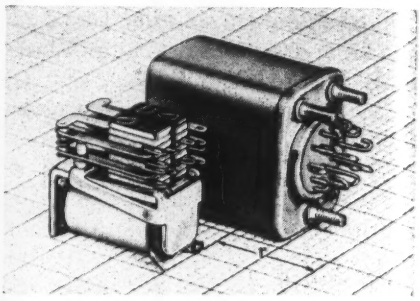
New Parts

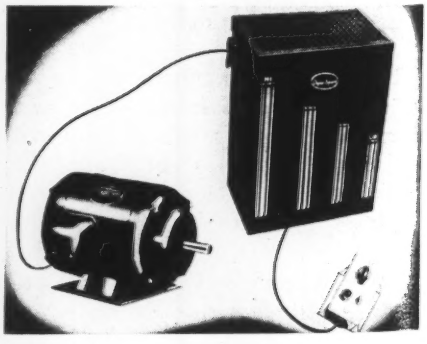


contacts, it is 1 11/32 in. long 11/16-in. wide and 1 in. high. Hermetically sealed base dimensions are 3/32 x 1 11/32 x 1 41/64 in., with 14-pin solder terminal header and six contact springs per stack, 12 springs total per relay. Models are available to meet military specifications for shock and vibration and to withstand wide temperature variations. Relay is furnished for any voltage to 110 v dc and with up to six contact arms per stack, 12 arms total. Made by **Magnecraft Electric Co.**, 1442-M W. Van Buren St., Chicago 7, Ill.

For more data circle MD-99, Page 187

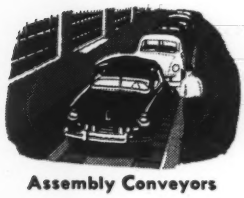
Motor Control Systems

Redesigned line of electronic variable speed motor control systems includes models from 1/15 to 3 hp. Units have special terminal block transformer construction and critical component plug-in assemblies. Motor series field is

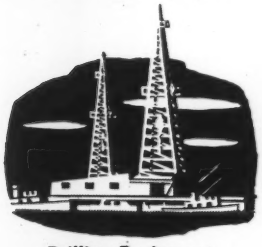


utilized as a torque signal source in a feedback circuit to provide constant system torque capability. Controlled acceleration on many models allows use on high inertia loads without placing excessive torque load on materials in critical processes. Models are available

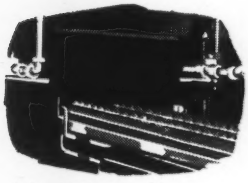
Construction Machinery



Assembly Conveyors



Drilling Equipment



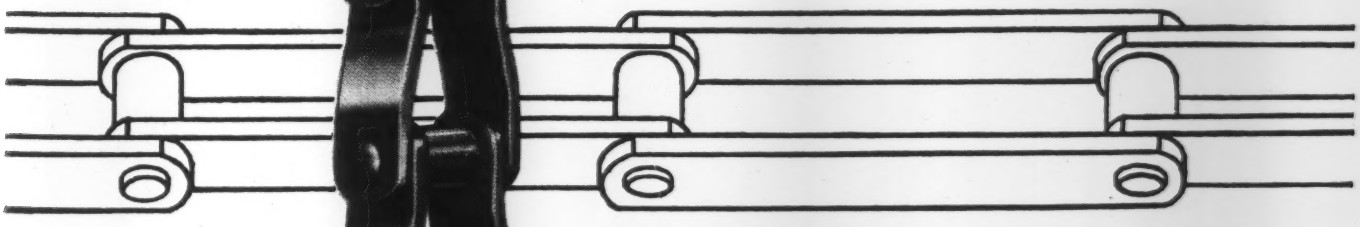
Heat-Treating Furnaces

When COST is an OBJECT

Whether that cost is first or operating, it will pay dividends to investigate the saving possibilities of Rex Chabelco Steel Chain. It has the *extra* strength, *extra* stamina and *extra* quality needed for longer trouble-free operation.

For drive or conveyor service, where loads are heavy, speeds slow to moderate . . . where operating conditions involve temperature extremes, dust, dirt or heavy shock loads—*these steel chains will save you important money.* And, they run on cast sprockets . . . another important cost-cutting advantage.

Why not have your Chain Belt District Sales Engineer check your chain requirements with you. He may be able to save you important money—he has for other Design Engineers. Meanwhile, send for Bulletin 53-59. Chain Belt Company, 4643 W. Greenfield Ave., Milwaukee 1, Wisconsin.



CHAIN BELT COMPANY

District Sales Offices in all Principal Cities

Could you do this with any other leather packing?

WHEN SQUEEZED . . .

. . . EVEN TIGHTLY CLOSED . . .

. . . IT SPRINGS OPEN!

It's Resilient!

VIM 1243-3

LEATHER CUP PACKING

(rubber-impregnated)

Sealing the tiny interstices in leather . . . thoroughly . . . makes the big difference. We've done it with a special type of synthetic rubber.

You benefit by that difference . . . in packings that last longer and produce tighter seals. They just don't seem to wear out, users tell us.

This Houghton development combines the best features of both leather and rubber packings. It gives you leather's strength, low friction, and long life, plus the non-porosity and resilience only rubber provides. And add to this a new design feature that has revolutionized packing tradition.

That's VIM 1243-3, the biggest advance in cup packings in the past twenty years. Ask the Houghton Man, or write E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

GET THIS "PACKING STANDARDS" BOOK
listing standard sizes accepted by industry.
It will be mailed without cost to you.

VIM and VIX-SYN PACKINGS
. . . products of

E. F. HOUGHTON & CO.
PHILADELPHIA · CHICAGO · DETROIT · SAN FRANCISCO

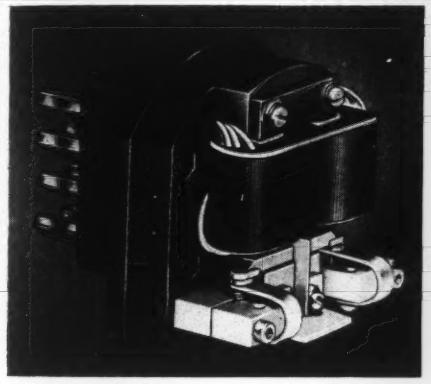
Ready to give you on-the-job service . . .

with various types of controls, including automatic and remote. Made by **Brown-Brockmeyer Co.**, P. O. Box 989, Dayton 1, O.

For more data circle MD-100, Page 187

Polar Relay

Sensitivity for high-speed pulse repeating is characteristic of the PTW polar relay for use where low current is transmitted over long lines. No critical adjustments are necessary, since spacing of contacts is by setscrew adjustment.



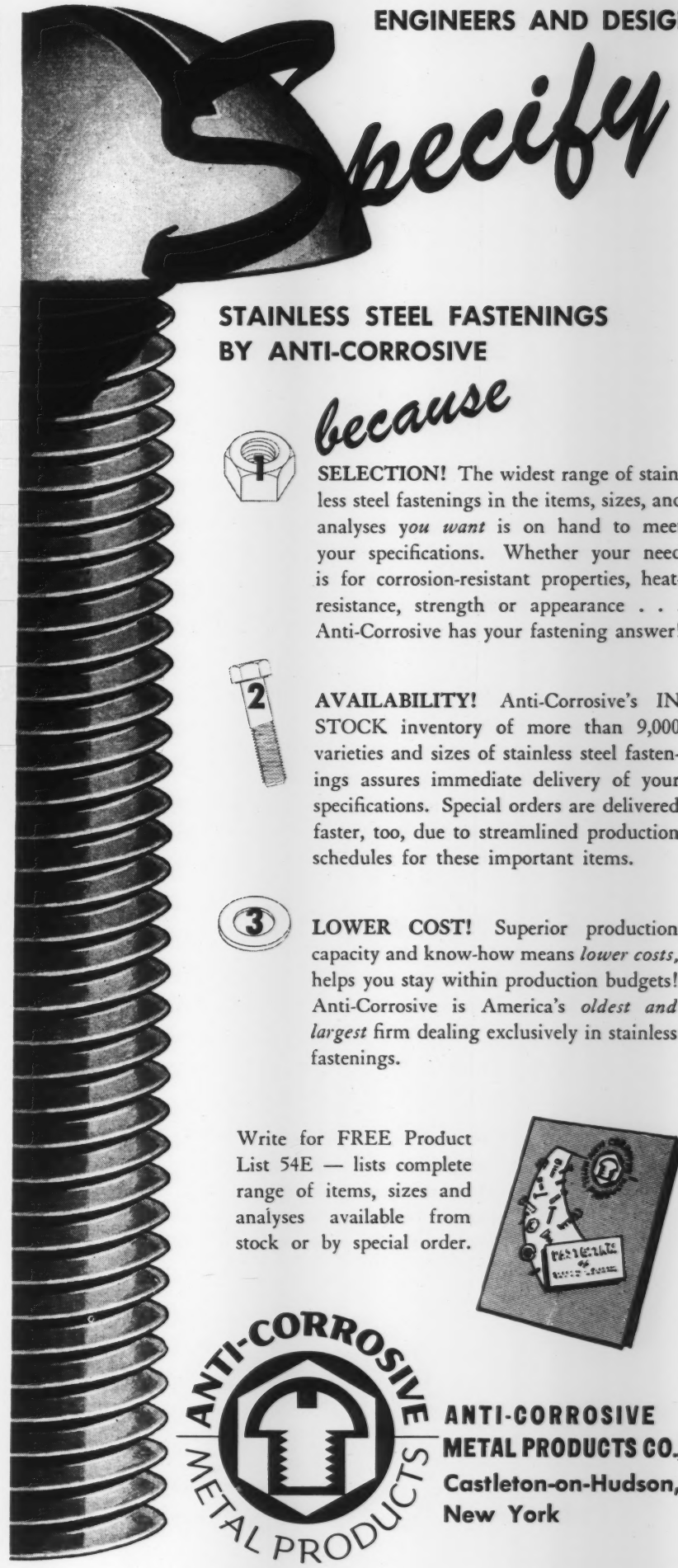
Relay has snap-on cover and can be used for line current direction indication or as differential relay in Wheatstone bridge type of control. Available from **Automatic Electric Sales Corp.**, 1033 W. Van Buren St., Chicago 7, Ill.

For more data circle MD-101, Page 187

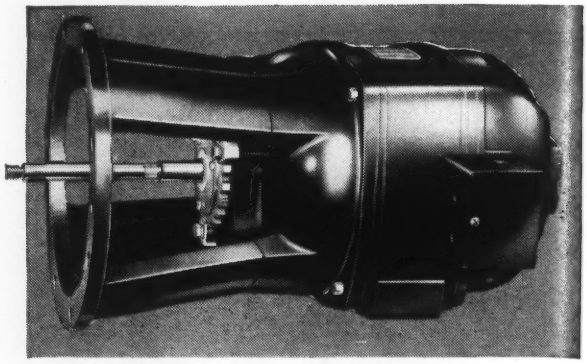
Miniature Potentiometer

Miniature precision sine-cosine potentiometer operates on either alternating or direct current. A resistance device, it works on the principle that the wiper voltage is proportional to resistance. Measuring 1-3/32 in. diameter by 11/16-in. long and weighing 1 oz, it performs the sine-cosine function at high impedance levels and without loss of resolution and can be operated at extremely high shaft velocities without producing phase distortions or amplitude modulations. It incorporates a noninductive carbon-film resistance element

(*Continued on Page* 220)



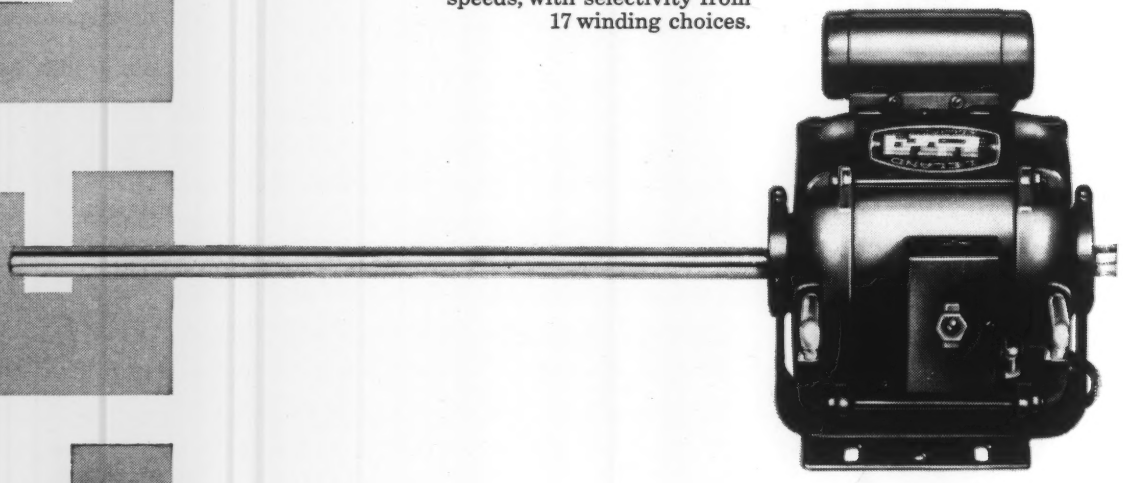
LELAND

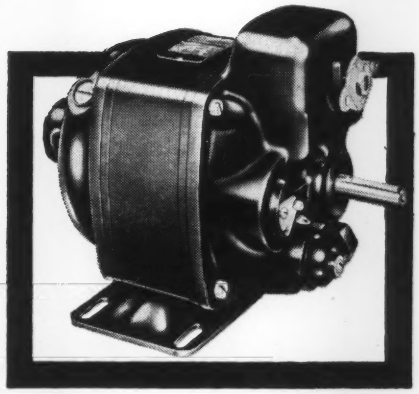


Unique Leland motor, designed to mate precisely with vacuum pump, provides micrometer axial shaft positioning and pump impellor adjustment.

LELAND'S Creative is more than

Year-round "thermal conditioning" in an unusual ventilating unit is quiet and comfortable, thanks to the enclosed, efficient Leland motor power. Special extended blower shafts turn at high or low speeds, with selectivity from 17 winding choices.





The Leland-developed explosion-proof motor that for 30 years has outsold all other makes combined for powering gasoline curb pumps.

Electrical Engineering a phrase!

Leland's whole organization is particularly geared to serve the needs of the Original Equipment Manufacturer. When his exact requirements cannot be filled by one of the many *standard* types of Leland motors, Leland engineers *welcome* the opportunity to work closely with his products' engineers to provide the required mechanical or electrical design.

During more than 30 years, Leland's *creative electrical engineering* has produced hundreds of special motor designs . . . each ideally suited to a specific application. These designs, carefully filed for quick reference, now provide ready-made answers to many current application problems, often enabling Leland to fill special motor requirements with maximum speed and economy.

Leland's representatives are graduate engineers, thoroughly qualified to grasp and discuss your motor needs. If these needs fall within the 1/6 to 5 HP range, you'll do well to contact your local Leland representative . . . or write or phone direct to—

Special features of this Leland food machinery motor design include interchangeable mounting for ¾, 1 or 1½ HP, single phase or three phase.

The LELAND ELECTRIC Co.

DAYTON 1, OHIO

Division of AMERICAN MACHINE & FOUNDRY COMPANY, New York
In CANADA, Leland Electric Canada, Ltd., Guelph, Ontario

AMF products are better . . . *by design*

Cork-and-rubber tape stops metal-to-metal squeaks

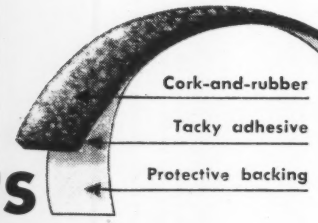
In bus bodies, and in locomotives and automobiles, too, a strip of Armstrong's DK-153 Cork-and-Rubber Tape effectively silences squeaks and rattles.

Besides acting as a vibration damper and shock absorber, the friction of DK-153 Tape's cork-and-rubber surface prevents most of the sliding that causes squeaks.

This unique material is also used as an anti-skid pad on small appliances to prevent sliding on polished desks and tables. It doubles as a cushion and seal in glass-to-metal joints in parking meters and vending machines. It also is used to protect fragile parts from breakage and scratching during shipment.

DK-153 carries its own adhesive. To apply it, you just peel off the cloth backing and press the tape into place.

You can get Armstrong's DK-153 Tape in sheets, rolls, ribbons, or die-cut shapes, and in a wide variety of widths and thicknesses. For samples, write on letterhead to Armstrong Cork Company, Industrial Division, 7306 Dean Street, Lancaster, Penna. Available for export.

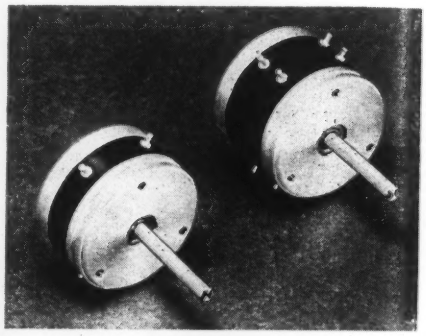


ARMSTRONG'S
DK-153 TAPE

New Parts

(*Continued from Page 217*)

of virtually infinite resolution. Both sine and cosine outputs are produced simultaneously. Standard

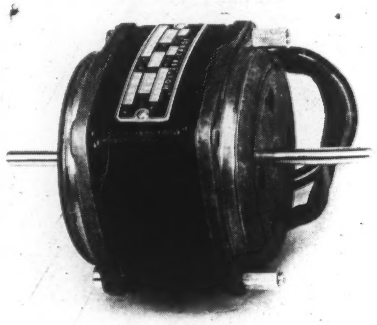


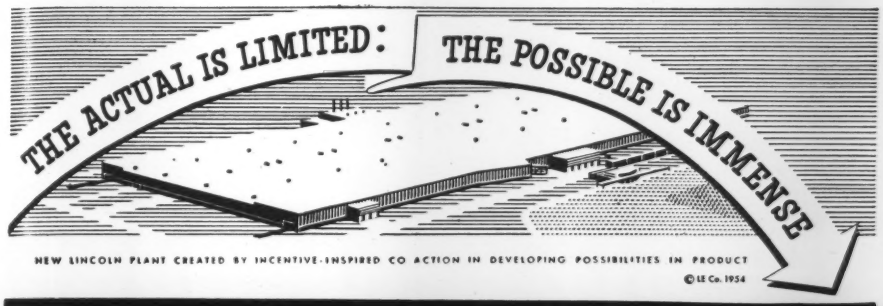
type 106 potentiometer, left, is equipped with double ball bearings and has a flange type servo mounting. Two or more can be ganged in factory-assembled units, right, without loss of mechanical or electrical accuracy. Modified type 106J, equipped with a sleeve bearing rather than ball bearings, may have either a bushing or flange type mounting. Shaft extensions are limited to one end only, and ganging is restricted to two sections. Made by **Computer Instruments Co.**, 1964 Utica Ave., Brooklyn 34, N. Y.

For more data circle MD-102, Page 187

Polarized Motor

Model RBCP polarized synchronous motor always pulls into synchronous speed with the rotor in the same position with respect to polarity of the motor field. Motor is rated at 0.3-oz-in. torque, 3600 rpm, continuous 40 C rise for use with 115-v, 60-cycle ac. Input is 12 w. Typical application is in driving an instrument type dc-ac





PROPER DESIGN IN WELDED STEEL IS *ALWAYS* LOWER IN COST

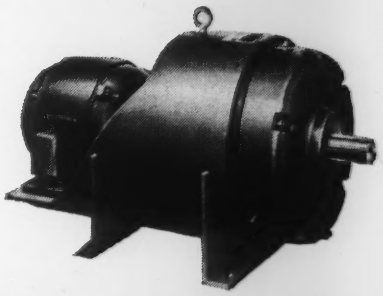
Material Cost is Less—It's a fact . . . steel is three times stronger than iron, two and a half times as rigid. Where strength alone is needed, one-third the metal is necessary. When rigidity is important, less than half the material is required. But steel costs only one-third as much per pound. Steel is more easily placed where it can carry more load per pound of metal. As a result, ultimate savings with steel are limited only by the resourcefulness of the designer.

Manufacture is Simpler—Fewer manhours . . . simpler, less costly production tools are needed to manufacture products from steel. By proper design, many operations needed for machining castings can be eliminated entirely. Assembly operations can be simplified . . . finishing and cleaning manhours reduced substantially.

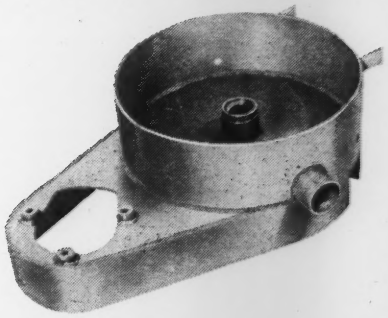
Products designed in steel have a modern appearance to improve selling appeal while reducing costs on an average of 50% according to field reports.

HOW TO START A COST REDUCTION PROGRAM

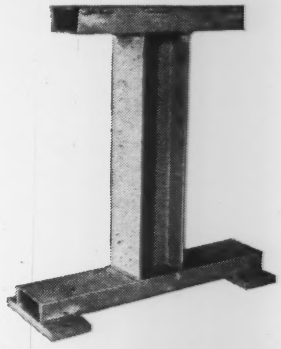
Your Lincoln Representative is a specialist in welded design. We will gladly assist your engineers in restudying designs to determine where and how welded steel can save an average of 50% in the manufacture of your products. Call or write. Design Bulletins available to product engineers by writing on your letterhead to



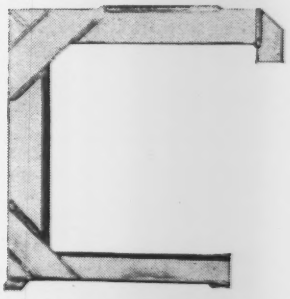
Welded Design Saves 50% *on motor gear housing. Original cast construction weighed 175% more...required 90% more machining.*



Once Cost $22.39 . . . Now Costs $12.27
Base for machine now stronger . . . more rugged yet weight is cut from 67 pounds to 43 pounds.



Cost Down 57% *on machine stand by change to welded steel. Also eliminates milling and drilling on former castings.*



Eliminates Scrap, *saves 21 pounds of material on each machine frame. Costs 33% less to manufacture by use of square tubing and arc welding.*

THE LINCOLN ELECTRIC COMPANY

Dept. 1105

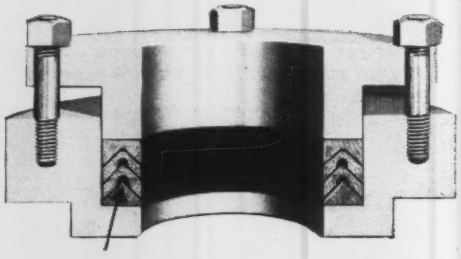
CLEVELAND 17, OHIO

THE WORLD'S LARGEST MANUFACTURER OF ARC WELDING EQUIPMENT

Why users prefer CHEVRON* Packing

for rams, plungers, reciprocating rods

1. *Assures a low friction, positive seal*
2. *Lasts much longer, needs less maintenance than ordinary V-type packing*
3. *Works efficiently in a shallow stuffing box*



Note the exclusive hinge-like construction of CHEVRON packing.

Garlock 431 CHEVRON Packing

GARLOCK CHEVRON Packing is entirely different from ordinary V-type packings. With *increasing* pressures CHEVRON rings tighten and prevent leakage; with *decreasing* pressures the packing eases off and permits operation with a minimum of friction.

Service reports, such as those below, prove that CHEVRON packing seals better and lasts longer.

▶ On hydraulic press—40″ ram, 6,000 p.s.i., ram honed and chrome plated, gland machined to give clearance of .006″ between gland and ram. Garlock 431 CHEVRON size 40″ x 41½″ x only 2″ deep gave 14 years service.

▶ On a machine with hydraulically operated clutches—¾″ cylinder, maximum pressure 500 p.s.i., service intermittent, maximum travel ¾″. First used cups, then "O" rings, neither of which worked well. Now packed with Garlock 431 CHEVRON ⅜″ x ¾″ x $\frac{17}{32}$″ deep and doing a smooth, positive sealing job.

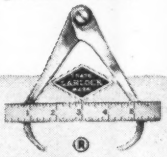
Ask your Garlock representative to give you all the cost-saving facts about CHEVRON packing, or write for folder AD-115.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Cleveland Denver • Detroit • Houston • Los Angeles • New Orleans • New York City • Palmyra (N.Y.) • Philadelphia Pittsburgh • Portland (Ore.) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

*Registered Trademark



GARLOCK

PACKINGS, GASKETS, OIL SEALS, MECHANICAL SEALS

RUBBER EXPANSION JOINTS

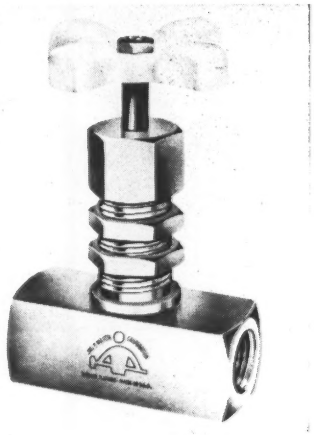
New Parts

synchronous chopper. Made by Holtzer-Cabot Motor Div., **National Pneumatic Co. Inc.**, 125 Amory St., Boston 19, Mass.

For more data circle MD-103, Page 187

Needle Valve

PM series panel-mounted needle valve can be installed in seconds' time. Machined from heavy steel bar stock, valve is designed for a maximum working pressure of 10,000 psi for use on water, oil or gas.

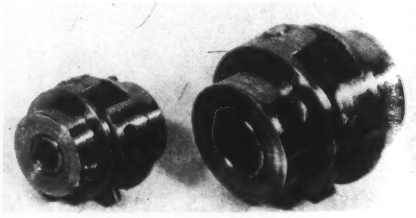


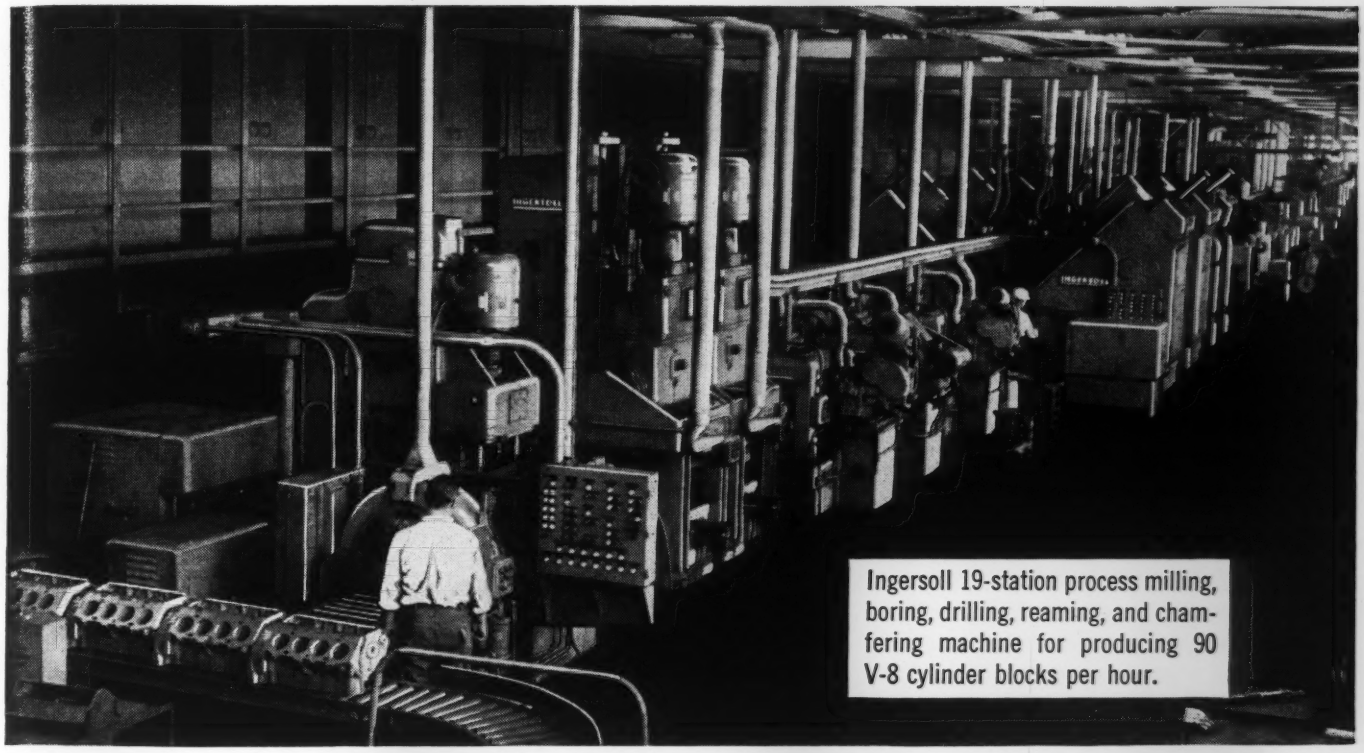
Valve stem is 416 stainless steel, precision machined with fine pitch threads to permit close throttling, and is sealed with Marpak packing. Made by **Jas. P. Marsh Corp.**, Skokie, Ill.

For more data circle MD-104, Page 187

Shaft Couplings

Illustrated are the two smallest models in a new line of precision shaft couplings. Coupling 0.5-in. in outside diameter and 0.5-in. long, for shafts to 0.1875-in. diameter, allows ±0.02-in. by ±5 deg misalignment. Coupling 0.75-in. in outside diameter and 0.75-in.





Ingersoll 19-station process milling, boring, drilling, reaming, and chamfering machine for producing 90 V-8 cylinder blocks per hour.

automation at its best uses VICKERS® hydraulics

One operator controls this entire machine in which a total of 20 milling, 18 boring, 16 chamfering and 4 drilling spindles are at work simultaneously. A hydraulic transfer mechanism moves the V-8 engine blocks automatically from station to station . . . turning them as needed . . . clamping and unclamping. Feeding of the tools is also done hydraulically. The entire operation is controlled by electro-hydraulic circuits from the loading station.

Vickers Hydraulics was used throughout by The Ingersoll Milling Machine Company. Among the advantages gained by using Vickers Hydraulics are: (1) simplification of design, (2) flexibility of control, (3) instantaneous response, (4) ease of providing interlocks and overload protection, (5) low maintenance with minimum down time.

The Vickers Application Engineer near you will gladly supply any additional information you may desire regarding the many benefits to be gained by using Vickers Hydraulics.

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

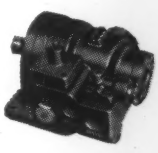
1430 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices:

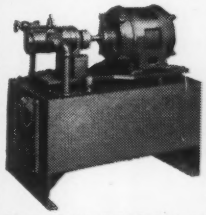
ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA (Metropolitan) • PITTSBURGH • ROCHESTER • ROCKFORD SEATTLE • TULSA • WASHINGTON • WORCESTER

Representative Standard VICKERS® Units Used on Ingersoll Transfer Machines

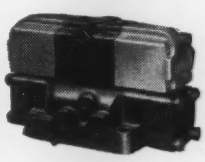
Single Stage Balanced Vane Type Pump



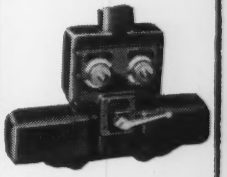
Double and Two-Pressure Balanced Vane Pumps



Power Unit is Self-Contained Power Source



Solenoid Controlled Pilot Operated 4-Way Valve



Traverse and Feed Cycle Control Panel

Balanced Piston Type Relief Valve

6684

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

FAIRFIELD

● If Gears are a part of the machines you make, there is no finer recommendation for YOUR PRODUCT than to be able to say it is "Equipped with FAIRFIELD GEARS!"

By specializing exclusively in *Fine Gears Made to Order* for thirty-five years, Fairfield has become one of America's largest producers of these parts. Fairfield's facilities are unexcelled. Here "under one roof" in a new and ultra-modern plant designed especially for the purpose, Fairfield has everything needed to produce your gears EFFICIENTLY, ECONOMICALLY. *Call or write for information TODAY.*

Fine Gears Made to Order

SPIRAL BEVEL • STRAIGHT BEVEL • HYPOID
HERRINGBONE • HELICAL • DIFFERENTIALS
SPUR • WORMS AND WORM GEARS

Ask for copy of Bulletin.

FAIRFIELD MANUFACTURING CO.

for FINE GEARS

2307 SOUTH CONCORD ROAD LAFAYETTE, INDIANA

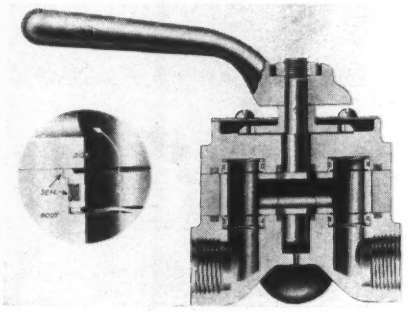
New Parts

long, for shafts to 0.375-in. diameter, allows ±0.03-in. by ±5-deg misalignment. Applications include use with rotating components in computer, servo and control mechanisms. Made by **Ward Associates**, 2926 Balboa Ave., San Diego 9, Calif.

For more data circle MD-105, Page 187

Hydraulic Selector Valve

Selector valve is capable of handling pressures up to 6000 psi. Low turning torque is result of design which eliminates directional fluid pressure on the port selecting disk



and causes it to "float" in its chamber. Highly finished parts and O-rings eliminate internal leakage. Valve is available ported as desired with side or bottom pipe tap and sub-plate mounting. Sizes of ⅜ to 1 in. are available for 0 to 2000 psi and ⅛ to 1 in. for 0 to 6000 psi are available for most services. Air and gas service units are available for 0 to 1000 and 0 to 3000 psi respectively. Made by **Republic Mfg. Co.**, 1930 W. 77th St., Cleveland 2, O.

For more data circle MD-106, Page 187

Laminated Plastic

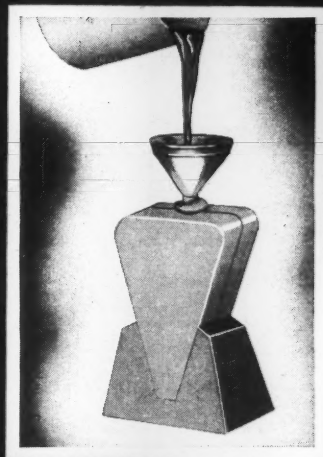
Expected to find application in the electronics industry, grade FF33 Formica is a fine weave glass fiber cloth, impregnated with a special new resin. Properties include low moisture absorption, great arc resistance, good dimensional stability; high dielectric strength; low loss electrical properties; dependable continuous service at temperatures to 350 F; and good chemical resisting prop-

Simplify Your Production Methods

with Thiokol® Liquid Polymer LP-2

A pourable liquid that converts to a rubber at room temperature WITHOUT SHRINKAGE

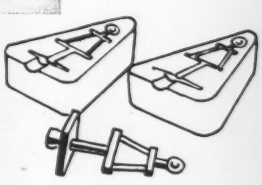
Thiokol LP-2 is now used successfully in many critical applications.



PERMANENT FLEXIBLE SEALS

that form tough, resilient bonds with glass, metal, plastics, synthetic rubber, wood and leather.

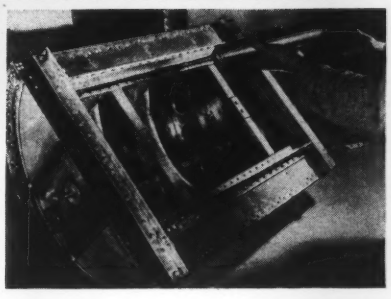
Sealer made by Minnesota Mining and Manufacturing Company, Detroit, Michigan.



COLD CASTING COMPOUNDS

that conform to exact dimensional shapes of intricate molds and cavities.

Cold casting compound made by Perma-Flex® Mold Company, Columbus, Ohio.



OIL AND SOLVENT SEALS

that seal joints in aircraft wings and other tanks for fuel and solvent retention.

"Thiokol" LP-2 compounds can easily be flowed into place by pouring or by pressure-feed. They cure to elastomers with the following properties:

TOUGHNESS AND RESILIENCE • HIGH BOND STRENGTH
OIL AND SOLVENT RESISTANCE • MOISTURE AND GAS IMPERMEABILITY
BROAD SERVICE TEMPERATURE RANGE • OZONE, SUNLIGHT AND AGING RESISTANCE
DIMENSIONAL STABILITY

The properties of "Thiokol" LP-2, both as a liquid and as an elastomer, simplify production methods and yield desirable product characteristics in the applications illustrated here. "Thiokol" LP-2 may yield similar advantages in your product or process. Our technical staff will gladly discuss the suitability of "Thiokol" LP-2 for any application you have in mind.

Thiokol Chemical Corporation supplies LP-2 only as a raw material. Because of its desirable properties, it was selected as the elastomer for the applications pictured here.

For complete information, write to: **Thiokol® Chemical Corporation**

784 NORTH CLINTON AVENUE • TRENTON 7, NEW JERSEY

In Canada: Naugatuck Chemicals Division, Dominion Rubber Company, Elmira, Ontario

where Quality counts

in a HEAT RESISTANT FINISH

High Temperature Electric Furnace made by Hevi Duty, Milwaukee, for heat treating high speed steel. Has inside temperatures of 2600°F. Finished in SICON green L6x642.

"DRESS UP" Your Laboratory in COLOR!

. . . with Sicon Silicone Coating

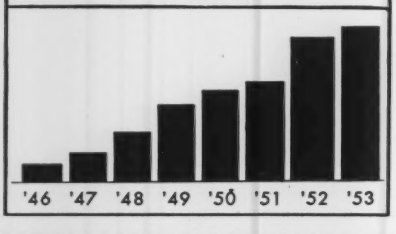
Note how an ordinary heat resistant finish starts to peel and crack a short while after application to heat-producing equipment.

HEVI DUTY uses SICON for protection against heat *and* to give greater color appeal

SICON not only provides better protection for products of the Hevi Duty Electric Company, but adds *color* appeal, a combination never available before in a heat resistant finish until the advent of silicone resins.

SICON, the original silicone-base heat resistant finish, is now available in various colors. No longer is it necessary to use drab paints and coatings where heat is involved. With SICON, a whole new area of longer product life and decorative finishing is available to the design engineer. For "longer life" and greater "sales appeal" decide now to "SICON-IZE" your products.

Chart below shows 8 year growth of SICON, and reflects how widely it is serving American Industry.



MIDLAND Industrial Finishes Co.
Waukegan, Illinois
ENAMELS · SYNTHETICS
LACQUERS · VARNISHES
DEPT. MD 6

Write Today for Case Examples of Other SICON Applications on Industrial and Consumer Products.

Name_____ Title_____

Firm_____

Street Address_____

City and State_____

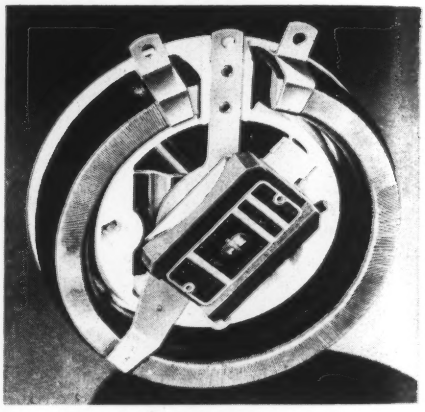
New Parts

erties. Made by **Formica Co.**, 4634 Spring Grove Ave., Cincinnati 32, O.

For more data circle MD-107, Page 187

Ring Type Rheostats

Smooth, accurate current control in ac and dc circuits is provided by Vitrohm ring type rheostats. Units have resistance values from 1 to 2500 ohms. They

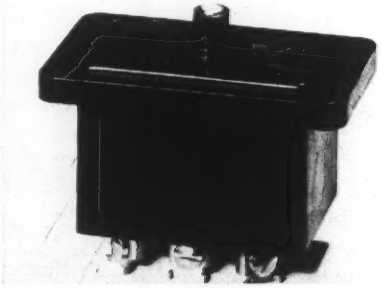


are rated 300 w based on 300 C rise. Balanced steel arm with copper graphite shoes and heavy compression spring maintains contact shoe pressure. Stop, which permits 317-degree rotation of contact arm, prevents overtravel. Made by **Ward Leonard Electric Co.**, 115 MacQuesten Pkwy S., Mt. Vernon, N. Y.

For more data circle MD-108, Page 187

Motor Protective Switch

Thermally operated Triplex motor protective switches are designed for the protection of three-phase motors. Two types are made for incorporation into motors and



How do you buy Socket Screws?

Do you specify some one make by *habit,* because you think *all* such fasteners are alike — all simply "screws with hex sockets?" If you do, and have never used P-K Socket Screws, break the habit *once* and give them a trial. You'll find that the hex shaped socket is about the *only* way other makes and P-K are "alike."

Look Beyond the Hex

It pays to look beyond the socket when you buy Socket Screws. Compare every detail of product and service, and you'll find P-K Socket Screws take top honors in every test for quality, performance, economy.

Why miss out on any of the advantages you can get with P-K Socket Screws? Try them. For samples, catalog, or any needed information, see your P-K Distributor, or write: Parker-Kalon Division, General American Transportation Corporation, 200 Varick St., New York 14.

The Only SIZE-MARKED Socket Cap Screws — with Gear Grip. Prevents errors . . . saves time and wasted screws when sizes get mixed up. Helps maintenance and service men in re-assembly. *Maximum Strength* — head, socket, threads accurately formed by P-K's cold-pressure process. Steel structure "flows" to conform to all contours, assures maximum strength at points of greatest stress.

FOR ADVANCED DESIGN that speeds assemblies — makes them simpler, stronger — and saves errors.

FOR TOP QUALITY and tolerance gaged to your most exacting specifications — and guaranteed.

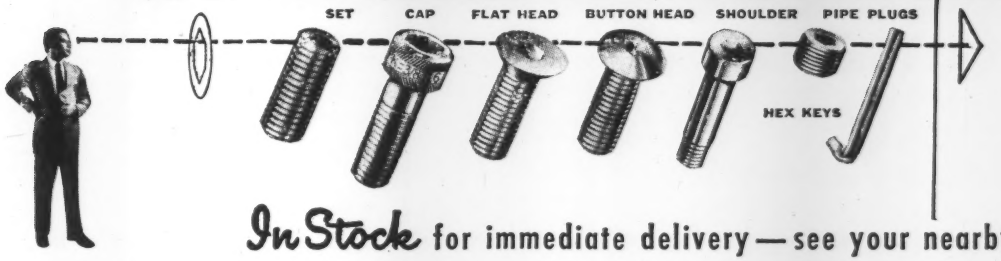
FOR ASSEMBLY STRENGTH okayed in a million punishing tests by thousands of satisfied users.

FOR PLANNING AIDS and buying data patterned to your special needs, plus advice on assembly.

FOR SUPPLY SERVICE set up for fast action and lower purchasing expense — by local Distributors.

GET **ALL** THESE ESSENTIALS OF COST-WISE ASSEMBLY

PARKER-KALON SOCKET SCREWS



SAY **P-K**

FULL RANGE of styles and sizes. You'll find any Socket Screw you need in P-K's complete line. Hex Keys in all sizes, and several handy sets.

In Stock **for immediate delivery — see your nearby P-K Distributor**

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To some, it means Sand Blasting . . . the big blow that gives old buildings that new look. But, to hundreds of industrial designers, it means Small Balls . . . at which Universal is best.

Sure, we make balls from the size of a mustard seed up to that of a walnut, each of them precisioneered for true roundness and silken silence. Write for details.

Universal Ball co.

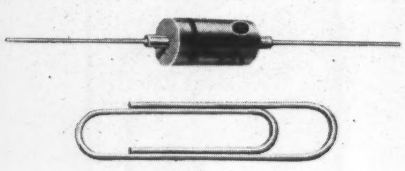
WILLOW GROVE
MONTGOMERY CO., PA.

for surface mounting, both available with or without manual release. Characteristics include amply rated bimetal thermal overload device, steatite base, simple release mechanism, simultaneous switch-off of poles, rapid restoration of circuit after operation, high efficiency and long working life. Maximum voltage rating is 500 v ac; current rating is from 0.1 to 25 amp. Switches measure 1.614 x 1.673 x 2.342 in. Made by **E-T-A Products Co.**, 915 W. Oakdale Ave., Chicago 14, Ill.

For more data circle MD-109, Page 187

Germanium Diodes

Red Dot series of diodes are for use in high-temperature applications. Designed for either clip-in or solder-in applications, diodes measure 5/32-in. in diameter and 3/8-in. long with 3/16-in. clip pins. They are supplied with No. 24 tinned copper, pigtailed leads. Type

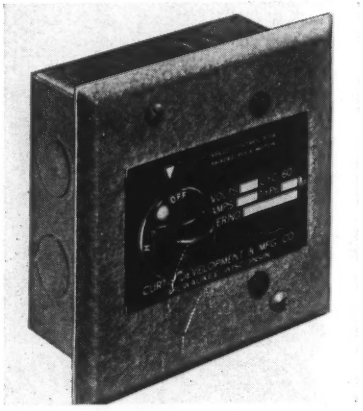


G44 has a minimum of 100,000 ohms resistance at −30 v and 100 C. Dc output current rating is 30 ma. All types exhibit good vibration, shock and moisture resistance. Made by **International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif.

For more data circle MD-110, Page 187

Speed Controls

Sturdy speed controls for shaded-pole motors up to 220 v, 60 cycles ac and motor currents up to 3 amp eliminate magnetic noises and, in most cases, provide low, medium and high speeds. Units are produced to required speeds of particular motor to be controlled and are available for mounting into existing outlet boxes, or flush, wall, and rear-of-panel mounting.

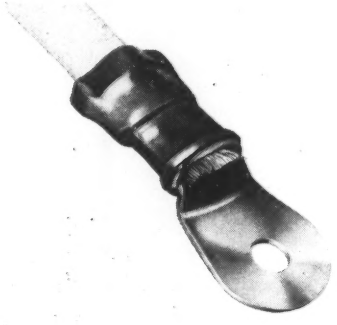


Controls operate within Underwriters' Laboratories temperature rise allowances. Made by **Curtis Development & Mfg. Co.**, 3266 N. 33rd St., Milwaukee 16, Wis.

For more data circle MD-111, Page 187

Insulated Terminal

Ampli-Bond terminal, for use with size 8 to 4/0 wire, provides a positive and complete bond of the insulation to the terminal sleeve. It also ensures uniform insulation thickness under confined crimping pressures and transmits crimping pressure evenly to the center of the crimp area. A separate, nonconducting metallic ring grips wire insulation, preventing exposure of conductor during sharp bends and cable fatigue caused by excessive flexing and vibration. The vinyl



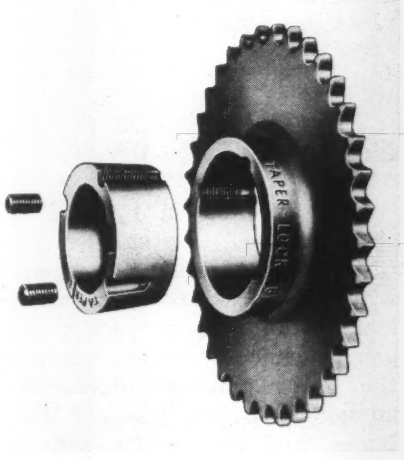
insulation will withstand a minimum of 6000 v. Terminal tongues have helical formation for strength. Terminals are color coded to facilitate identification of various wire sizes and are available in a variety of tongue shapes, stud sizes and in both butt and parallel connec-

tors. Made by **Aircraft-Marine Products Inc.**, 2100 Paxton St., Harrisburg, Pa.

For more data circle MD-112, Page 187

Roller Chain Sprockets

Expanded line of Taper-Lock sprockets now includes 1½, 1¾ and 2-in. pitch sizes, for chain sizes 120, 140 and 160, respectively. These sprockets are compact, having no flanges or protruding parts. They mount on the shaft



quickly and easily, hold firmly and are easily removed. Reusable, interchangeable locking bushings are available with ½ to 4½-in. bore and in a wide range of outside diameters to fit various sprocket and shaft combinations. Sprockets up through the 26-tooth size are made of high carbon steel and can be hardened; larger sprockets will be available in close-grained semi-steel. Made by **Dodge Mfg. Corp.**, Mishawaka, Ind.

For more data circle MD-113, Page 187

High Horsepower Motors

Now available in ratings to 150 hp, type SD totally enclosed motors offer protection against dirt, moisture, oil and chemicals; explosion-proof type SE motors serve where inflammable gases, volatile liquids or combustible dusts are present. Both types have built-in fans; asbestos-protected windings; easily removable stator cover

RELAYS THAT FIT

☆ electrically
☆ mechanically
☆ costwise

Over 5,348 standard Struthers-Dunn relay and timer types—each designed for a specific purpose—spell maximum efficiency and economy for the great majority of applications.

Equally important, more than 30 years of specialization in relays exclusively, means that Struthers-Dunn is uniquely fitted to recommend as well as to supply types that fit your particular application like the proverbial glove.

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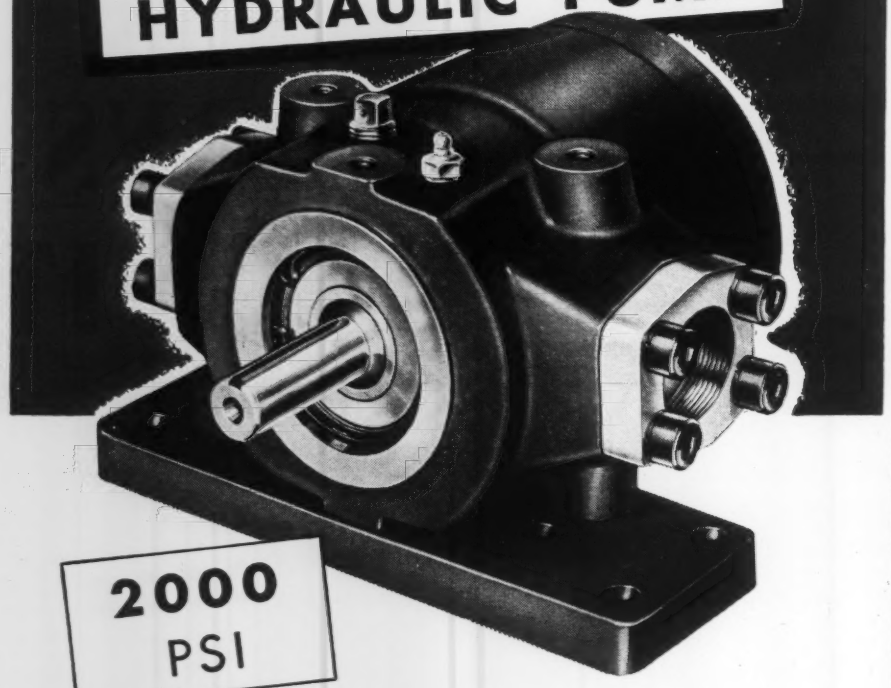
Announcing the New PF-100 Series DUDCO DUAL-VANE HYDRAULIC PUMP



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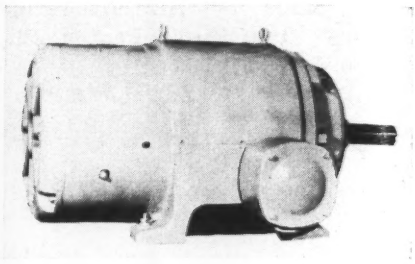
A High Pressure Pump at a Low Pressure Price!

- COMPLETE HYDRAULIC BALANCE . . . the exclusive DUAL-VANE Design provides and assures complete balance of all hydraulic pressure loads. You get continuous, maintenance-free operation with increased efficiency at all pressures.
- INCREASED OUTPUT . . . machine efficiencies can be increased by 2000 psi pump operation without change of other standard components in the hydraulic system.
- CARTRIDGE CONSTRUCTION . . . all pumping parts that move are contained within an easy-to-install cartridge. Pump output can be altered by changing cartridge; servicing is simplified and machine down-time reduced.
- ECONOMY . . . the low initial cost and the 2000 psi premium performance of DUDCO PF-100 Pumps can double the value of your *hydraulic dollar.*

Write for DUDCO Bulletin No. DP-302. You'll get the facts on the new PF-100 Series Pumps.

DUDCO DIVISION
THE NEW YORK AIR BRAKE COMPANY
1706 EAST NINE MILE ROAD • HAZEL PARK • MICH.

New Parts

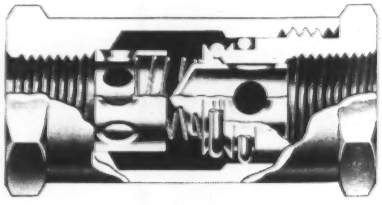


plate; solid, dynamically balanced cast aluminum rotor; Lubriflush bearings for relubrication without disassembly; and normalized castings for permanent accuracy. Made by **U. S. Electrical Motors Inc.,** P. O. Box 2058, Terminal Annex, Los Angeles 54, Calif.

For more data circle MD-114, Page 187

Check Valves

Now available in 1½ and 2-in. sizes as well as smaller sizes, Circle Seal check valve operates with low pressure drop and no leakage. In systems such as oxygen/propane or oxygen/acetylene, the valve prevents unintentional mixing of the two gases in supply hoses, and in circuits with two



cross-connected systems, it prevents escape of high-pressure fluids into low-pressure lines. Design also prevents reversal of flow. Valves are available in brass, aluminum or steel. Made by **James-Pond-Clark,** 2181 E. Foothill Blvd., Pasadena 8, Calif.

For more data circle MD-115, Page 187

Subminiature Switch

Flat terminal lugs of snap-acting type USM switch are widely separated in the switch base and have holes so located that wires up to No. 18 can be hooked into the

WANTED

AN ENGINEER—

who is having trouble working out a problem involving hydraulics.

This message takes only two minutes to read but may save you endless hours of hard work.

You know that the functions that play so important a part in any new mechanism are almost never outside the realm of someone else's thought or experience. Whether it be a servo-mechanism, a distinctive type of traction drive, an unusual motion or sequence of operations, the probability is: Hydreco engineers have either rubbed shoulders with the problem or actually worked it out!

Endless hours of concentration in finding the answer is hardly a virtue — if a simpler, more direct, proven solution is to be had. Management may admire long, studied application to a project, but appreciates a quick result much more.

Hydreco engineers, with years of intimate contact with all manner of problems involving hydraulics, represent a rich reservoir of factual information, experience and "savvy." They'll share it with you without cost or obligation on your part. Many of the products of America's top manufacturers are the result of such cooperation. There are many others which are simply project numbers today.

So, if you are stymied, puzzled or just need a fresh approach, write today.

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THE NEW YORK AIR BRAKE COMPANY
1106 EAST 222nd STREET • CLEVELAND 17 • OHIO

HYDRECO DIVISION
THE NEW YORK AIR BRAKE CO.
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Cleveland 17, Ohio

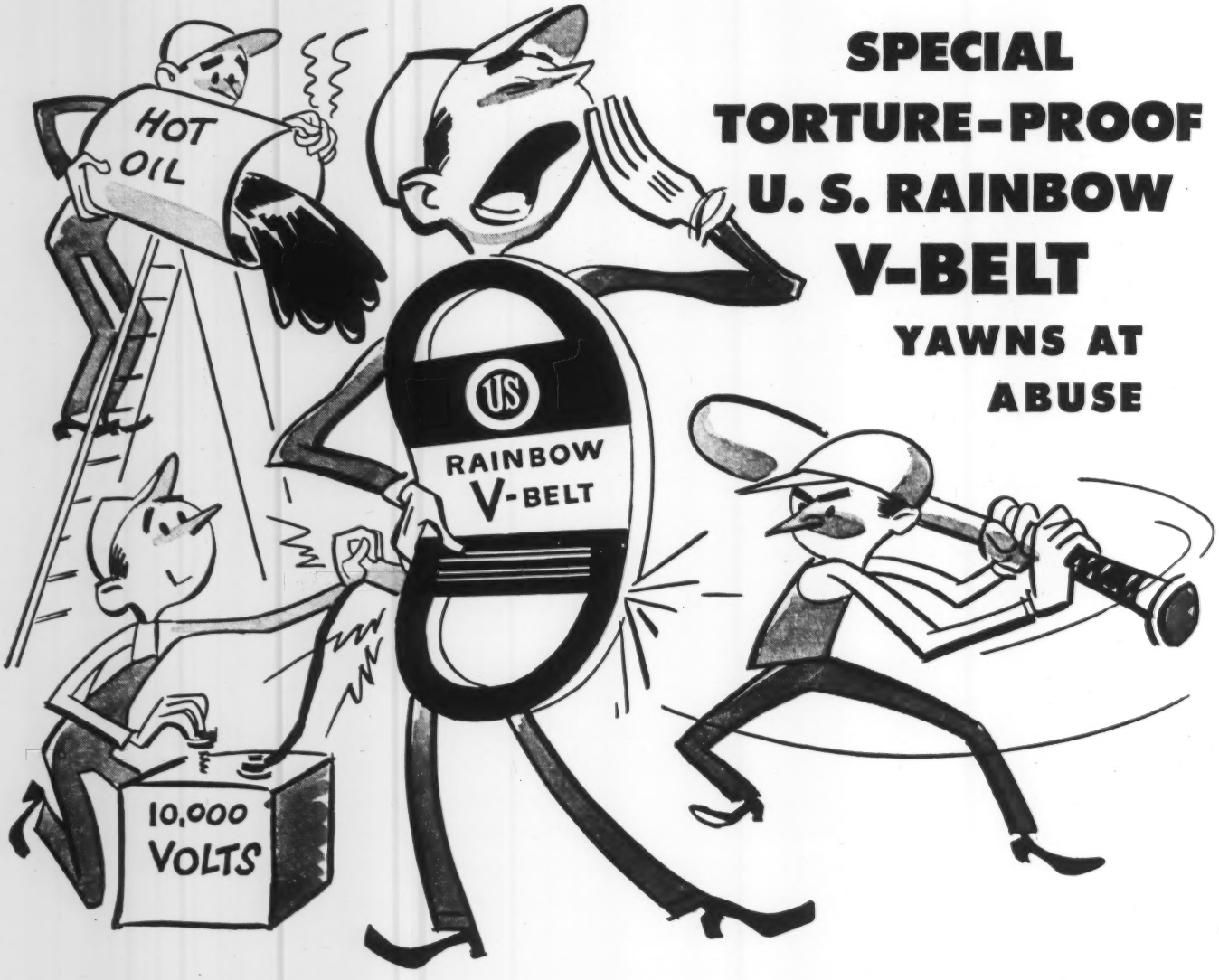
Without cost or obligation of any sort, I would like to discuss a problem in confidence with a Hydreco engineer.

Name.....

Company.....

Address.....

City.....Zone.....State.....



SPECIAL TORTURE-PROOF U. S. RAINBOW V-BELT YAWNS AT ABUSE

If your V-belts have to withstand conditions not found on the average drive, such as oil, high temperatures, static electricity—order U. S. Rainbow® V-belts compounded to handle such rugged treatment.

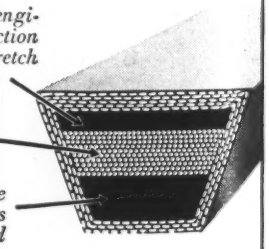
- Cords are treated with latex to reduce heat generated by constant flexing, and to get maximum adhesion between the component parts of the belt.
- Straight sidewalls provide extra pulling power by gripping the grooves for complete contact the full height of the belt.
- Protective jackets keep out dirt and prolong wear.

Order from your distributor, or contact any of United States Rubber Company's 26 District Sales Offices, or write to address below.

***Top rubber cushion** in closely engineered balance with the lower section . . . to keep cool under constant stretch and return.*

***Equa-Tensil Cord Section**— all cords scientifically placed, each pulling its share of the load.*

***A sturdy level cushion** for the Equa-Tensil Cord Section provides structural firmness for V-grooves and over the flat pulley of V-to-flat drives.*



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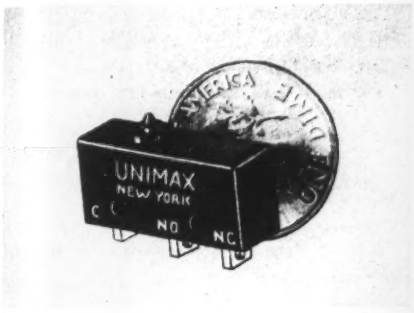
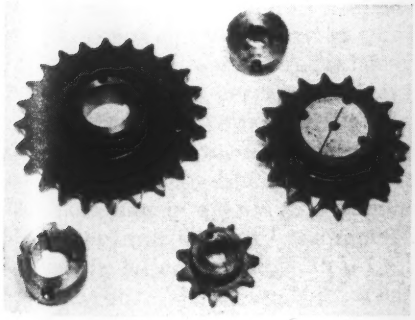


terminals from any direction for either single or ganged switch installations. Terminals are plated for soldering. Measuring 25/32 x 23/64 x ¼-in., the switch is available with plain or leaf actuator. It is rated for single-pole, double-throw operation at 5 amp 125 or 250 v ac, or 2 amp at 30 v dc. Made by Unimax Switch Div., **W. L. Maxson Corp.**, 460 W. 34th St., New York 1, N. Y.

For more data circle MD-116, Page 187

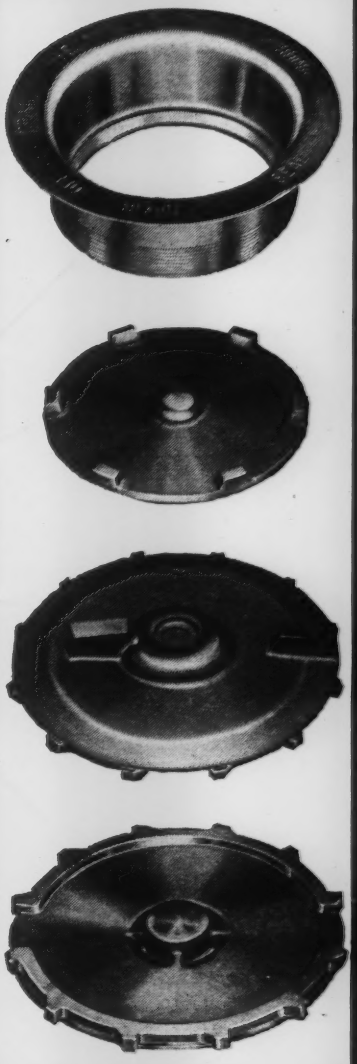
Roller Chain Sprockets

Single and double hub types of TaperLock roller chain sprockets are now available in sizes for No. 120 (1½-in. pitch), No. 140 (1¾-in. pitch) and No. 160 (2-in. pitch). Available are No. 120 single hub sprockets in nine sizes with 13 to 26 teeth and 75 hp maximum rating; No. 120 double hub driven, five sizes, 35 to 80 teeth; No. 140 single hub sprockets, ten sizes, 12 to 26 teeth, 95 hp maximum rating; No. 140 double hub driven sprockets, four sizes, 35 to 70 teeth; No. 160 single hub sprockets, 11 sizes, 11 to 26 teeth, 125 hp maximum rating; No. 160 double hub driven, three sizes, 35 to 60 teeth. Only five bushing sizes are required to fit the expanded line. They are



MUELLER BRASS CO. forgings* contribute to the efficiency of this modern waste disposal unit

*MUELLER BRASS CO. facilities include: designing, die-making, forging, tooling, machining, polishing, plating and assembly

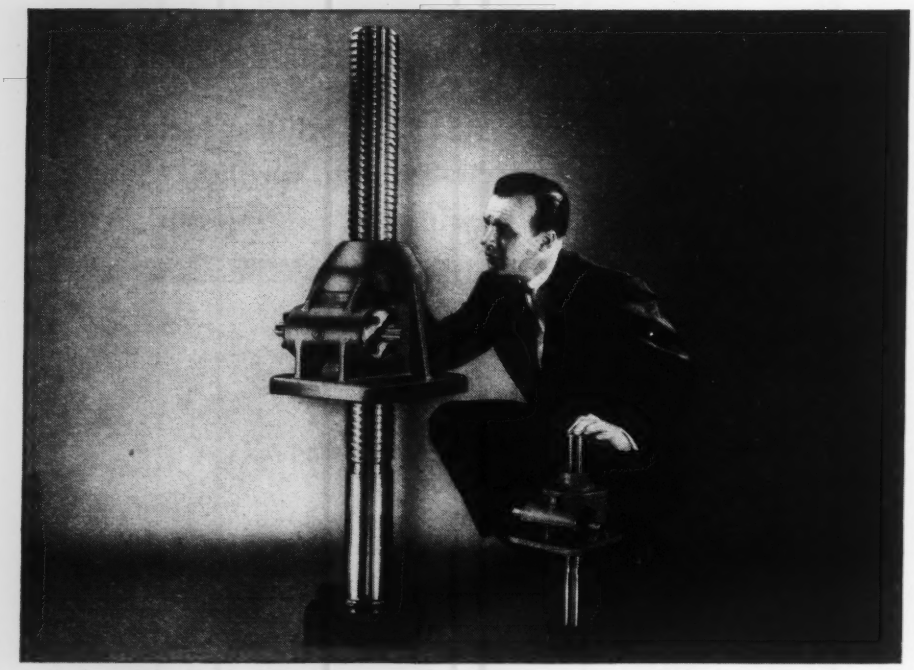


Three Mueller Brass Co. forgings play an important part in the fine operating performance of this modern waste disposal unit made by the Eureka-Williams Co., Division of the Henney Motor Co., Inc. This unit does a speedy and thoroughly effective job of pulverizing garbage and has made life easier for American housewives. The impeller disposer that chops up the waste food in the disposal unit, the disposer cover and the sink mounting flange are all forged by the Mueller Brass Co. This is another outstanding instance where Mueller Brass Co. forgings have improved product performance and cut costs. High quality forgings can be produced from standard and special brass, bronze and aluminum alloys. And in addition, the Mueller Brass Co. offers complete service ranging from product design to finished part . . . Write today for complete information and new 32 page forgings handbook.

1. Sink mounting flange, forged, machined, nickel and chrome plated by Mueller Brass Co.
2. Machined and finished disposer cover forging.
3. Cutting side of impeller disposer forged from 600 series bearing bronze.
4. Reverse side of impeller disposer.

MUELLER BRASS CO.

PORT HURON 15, MICHIGAN

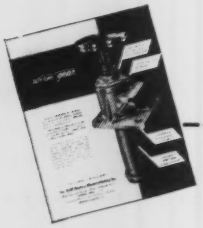


Here's A Device Every Machinery Designer Should Know About . . .

It's the Duff-Norton Worm Gear Jack, successfully used by many machine builders as a component of equipment for precise, positive control of linear motion, applying pressure, resisting impact. Two or more of these jacks can be connected by means of shafting and mitre gear boxes or any power-operated positive control system so that jacks always raise or lower under equal or unequal loads in perfect unison. Capacities range from 5 to 35 tons with any raise up to 25 inches; worm gear ratios, 8:1 to 96:1; turn of worm for each 1-inch raise, 10 to 180; available in either Acme or square threads. Screw ends and tops are available in many types and can be readily adapted to your specific requirements.

Thousands of these jacks are in use today for table adjusting—machine adjusting—rolling mill adjusting—raising and lowering conveyors, machine beds, molds and dies, furnace lids, loading platforms, loading racks, gates, hinged mechanisms, arbor presses—adjusting electrodes—overhead crane servicing.

Duff-Norton Worm Gear Jacks are available in 6 standard sizes or to your special order. For complete specifications and detailed drawings, send for your free copy of a special brochure.



DUFF-NORTON
Manufacturing Company

THE DUFF-NORTON MANUFACTURING CO.
DEPARTMENT MD
P.O. Box 1889, Pittsburgh 30, Pa.

Please send immediately a free copy of your new Worm Gear Jack Brochure.

NAME _____ TITLE _____

COMPANY _____ PHONE _____

ADDRESS _____

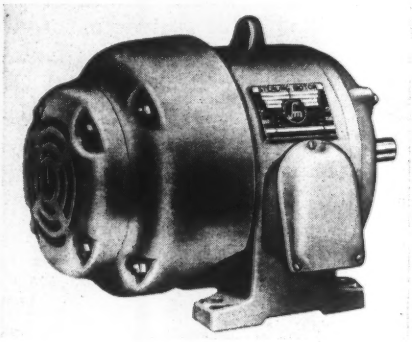
New Parts

stocked in 54 bore sizes. Made by **Morse Chain Co.**, 7601 Central Ave., Detroit 10, Mich.

For more data circle MD-117, Page 187

Totally Enclosed Motors

Klosd-Tite fan-cooled, constant normal speed motors are available in frame sizes 182 and 184, meeting the new NEMA approved standards. More than half of the inactive space in previous designs has been eliminated. Ball bearings



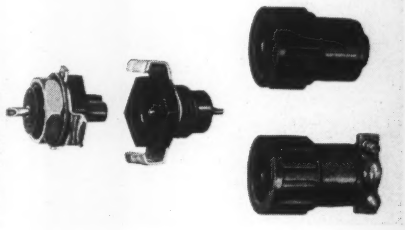
are double shielded and prelubricated, with extra grease reservoir. Diagonal cover type boxes may be rotated 360 degrees, to be fixed in any desired position, and have a tapped hole for conduit. Made by **Sterling Electric Motors Inc.**, 5401 Telegraph Rd., Los Angeles 22, Calif.

For more data circle MD-118, Page 187

Miniature Connectors

Series C-20 high-voltage, single-contact cable and panel connector, suitable for use as a feed-through, provides a means for passing a single lead through a rack and panel arrangement with the hood as a grip for disconnecting both parts. Connector has the extra-long barrier required for high arc resistance applications. Accidental disconnection between plug and socket is prevented by the construction of a vibration ring with detent action-locking vibration spring. Available in mineral filled Melamine, Plaskon reinforced alkyd type 440A or diallyl phthalate insulating materials, the connec-

tor has socket and pin contacts of spring temper phosphor bronze and brass, respectively. Voltage



breakdown at sea level is 3400 v rms; current rating is 5 amp. Available from Electronic Sales Div., **DeJur-Amsco Corp.**, 45-01 Northern Blvd., Long Island City 1, N. Y.

For more data circle MD-119, Page 187

Plastic Foam Materials

Available in a wide range of bulk densities, Eccofoam thermosetting plastic foam materials are low density, rigid and unicellular and are reaily machined. They have a thin skin on their outer surfaces and are available in specified shapes or in 18 x 30-in. sheets with 1, 2 or 3-in. thickness. The properties vary as a function of bulk density. With a bulk density of 10 lb per cubic foot, values include tensile and compressive strengths of 320 and 340 psi and modulus of elasticity of 11,000 psi. Materials have good thermal and electrical insulating properties and low water absorption. Made by **Emerson & Cuming, Inc.**, 869 Washington St., Canton, Mass.

For more data circle MD-120, Page 187

Pressure Regulators

Reduced pressure ranges of 5 to 50, 10 to 100 and 90 to 200 psi are available in line of pressure regulators, made in ¼, ⅜ and ½-in. pipe sizes. They handle inlet pressures up to 400 psi and are supplied with or without connections for pressure gages. Body

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You don't have shock and vibration problems every day — but when you *do*, you want them solved promptly. So you want the practical experience of men who've been spending *all* their time in this highly specialized engineering — men who have most likely met and successfully answered questions just like the ones that are bothering you. These men are Barry engineers — ready and able to analyze *your* shock and vibration problems, backed by a laboratory staffed and equipped to *prove* their solutions, and served by model shops geared to produce *your* prototypes whenever you need them.

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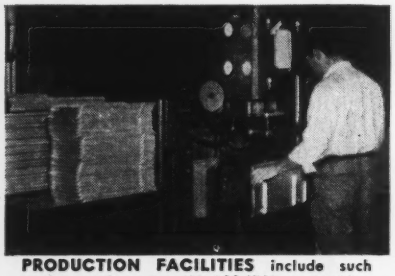

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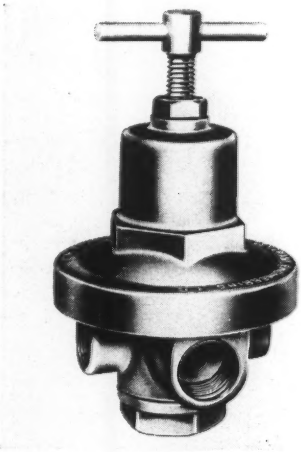
New Parts

parts are brass forgings. Valve is self-aligning and fully guided, allowing maximum air flow with minimum pressure drop. Metal

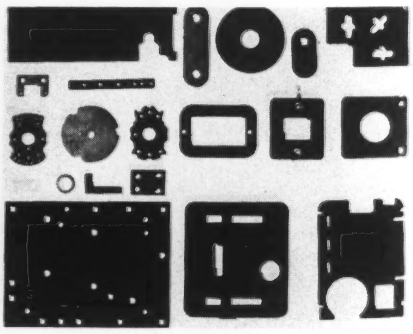


diaphragm permits use with air, water or oil. Made by **Generant Engineering Co.**, 260 S. Twentieth St., Newark 3, N. J.

For more data circle MD-121, Page 187

Phenolic Stampings

For experimental projects, pilot runs or limited quantity production, phenolic stampings can be produced in any size or shape up to 9 x 12 x ⅛-in. The stampings are die cut to specification, with tolerances held to ±0.002-in. under standard conditions. Applications include radio and electronic

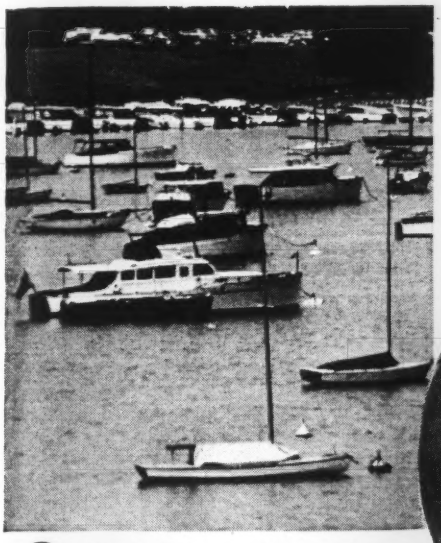


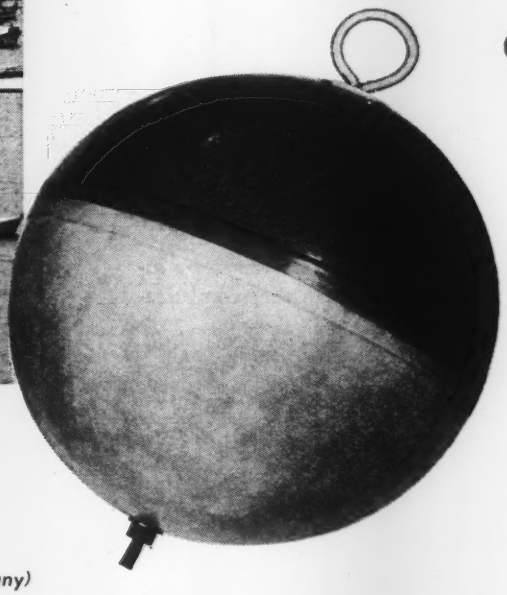
frames, insulators, panels, socket bases, mechanical gaskets, spacers and cams. Made by **Federal Tool & Mfg. Co.**, Dept. KP, 3600 Alabama Ave., Minneapolis 16, Minn.

For more data circle MD-122, Page 187

Ideas in the making!

ARALDITE® Epoxy Resins developed by Ciba Research are simplifying manufacturing methods, improving product efficiency and opening new fields of product development. The formulator and the end product producer will want to know more about them. We at Ciba want to help you further your development.



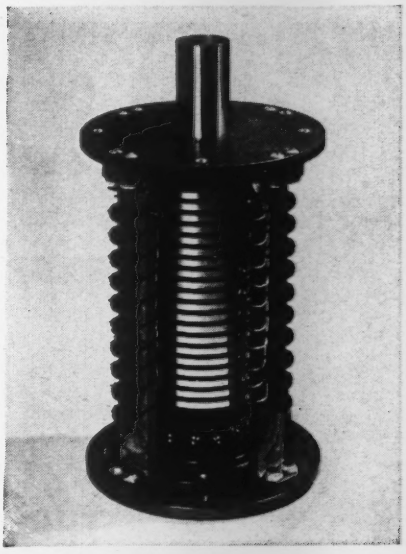


● ARALDITE IMPREGNATED MOORING BUOY IS STRONG . . . LIGHT . . . WEATHER-PROOF AND SINK-PROOF

(Courtesy United Pattern Company)

One-seventh the weight of a steel buoy of comparable size including the unicellular filling beneath the surface skin, this newest idea in modern maritime equipment eliminates hull-scuffing damage and is functionally superior in every other way. Since color is "built-in" with salt-water corrosion resistant laminate, it stays bright and new looking, thereby minimizing maintenance. All these advantages suggest a wide range of new and improved product development in which ARALDITE Resins may prove the answer for you.

SEND THIS COUPON . . . or write us on your company letterhead . . . for complete technical data on the physical properties and recommended procedures for the successful use of Araldite Resins for your fabricating needs.



● SLIP RING ASSEMBLY

The exceptional casting properties of ARALDITE Resins are demonstrated in this unit designed to operate with strain gauges or radar equipment. ARALDITE Epoxy Resins provide high dielectric strength, arc and humidity resistance which permit a current capacity of 5 amperes per ring.

(Courtesy Airflyte Electronics)

● 600 VOLT TRANSFORMER TYPE TWM

This example of ARALDITE Resin encapsulating insulation shows how completely it may be applied to encompass coils in housing in an application where rugged use can be expected for the entire life of the unit. *(Courtesy Allis-Chalmers)*

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MD-2

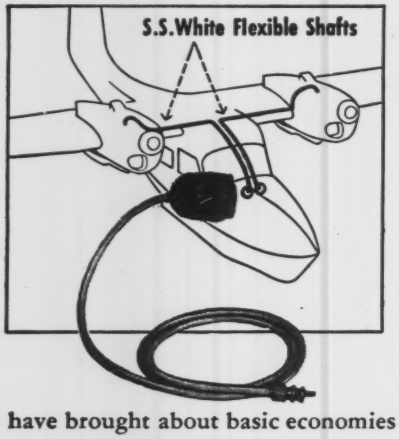
THE PROBLEM

FINDING AN ECONOMICAL WAY TO TRANSMIT POWER OVER LONG DISTANCES

In designing the instrumentation set-up for a small twin-engine amphibian plane, the engineers planned on using tachometers of the direct drive type. The problem of driving the tachometers was complicated by the fact that the engines were mounted on the wings at some distance from the point where the tachometers were to be installed. Intervening struts, frames and turns added further complications. The engineers found an answer in

THE LOW-COST SOLUTION

AN S.S.WHITE POWER DRIVE FLEXIBLE SHAFT



A single 11-foot power drive flexible shaft run between each tachometer and the power take-off on the corresponding engine did the trick. The flexibility of the shaft allowed it to be installed around the intervening obstructions, quickly, easily and economically. Operating at 2500 rpm, the shafts have given completely satisfactory service, according to the manufacturer. What's more, they can be readily removed and reinstalled whenever routine servicing becomes necessary.

This is one of many power drive applications in which S.S.White flexible shafts have brought about basic economies in design, in production and assembly. Why not consider their use on your own power drive applications?

The Design Engineers Bible

For full facts and data on how to select and apply flexible shafts, send for your free copy of the 256-page Flexible Shaft Handbook. Please write for it direct to us *on your business letterhead.*

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. 4, 10 East 40th St.
NEW YORK 16, N.Y.

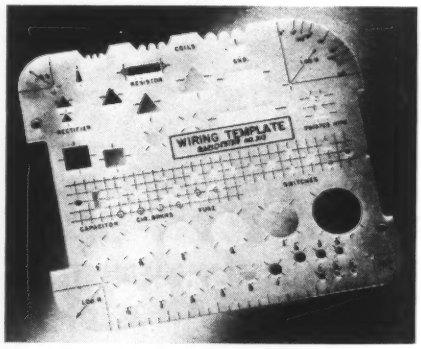
Western District Office • Times Building, Long Beach, California

ENGINEERING DEPARTMENT

EQUIPMENT

Wiring Template

No. 313 wiring template permits rapid drawing of electronic symbols conforming to JAN-STD-15 specifications. Sizes of the symbols are in multiples of 0.2-in., standard to the minimum allowed line spacing. Template can also be



used for general electronic drafting for straight edges, circles and corners. It is made from 0.030-in. matte finish plastic and has smooth milled cutouts. Overall size is 7 x 6⅛ in. Made by **Rapidesign Inc.**, P. O. Box 592, Glendale, Calif.

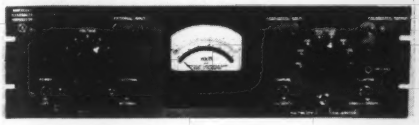
For more data circle MD-123, Page 187

Calibrator

Model 3 calibrator facilitates calibration of vacuum tube voltmeters and oscilloscopes in the low voltage ranges, providing a calibrated ac output voltage from 0.50-mv to 7.5 v with rms accuracy of 1.5 per cent or more over the frequency range of 25 cycles per second to 1000 cycles per second. A 60-cycle per second voltage supply is contained in the instrument; other frequencies can be applied to the "external" terminals. An unknown input applied to the "comparison" terminals can be measured on an oscilloscope connected

Engineering Equipment

to the "calibrated output" terminals. The precision meter can be used independently as a voltmeter with a range from 0 to 7.5 v and an accuracy of 1 per cent at 60 cycles per second. Calibrator is

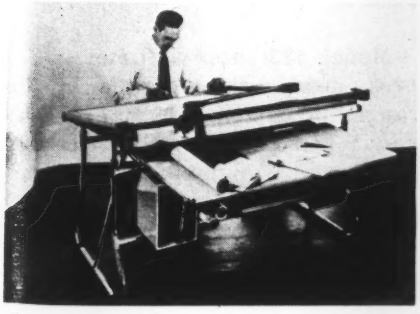


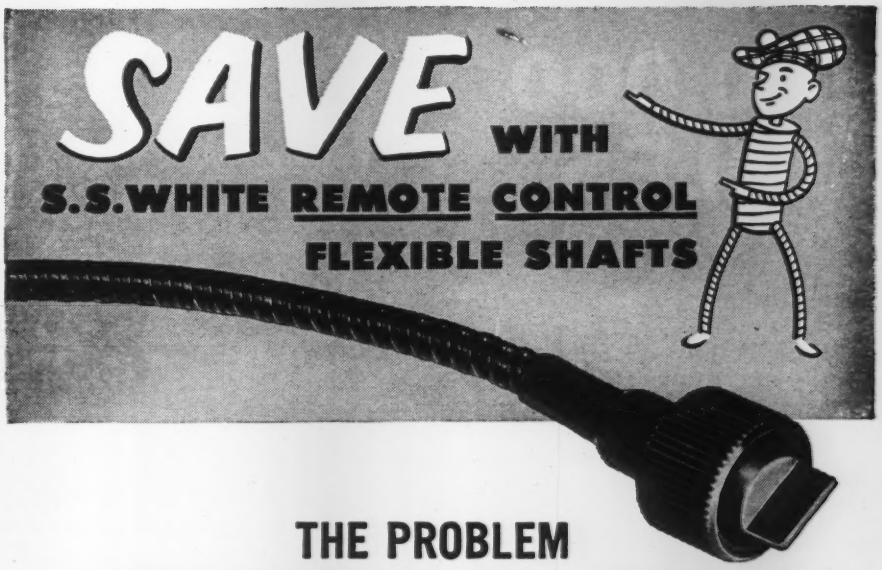
available for standard relay rack mounting or for portable use. It is 5¼ in. high, 4 in. deep and weighs 7 lb. Made by **Northeast Electronics Corp.,** Municipal Airport Bldg., P. O. Box 425, Concord, N. H.

For more data circle MD-124, Page 187

Drafting Table

Tecnibord drafting table is covered with a wide belt of flexible Bakelite Krene, which is attached to rollers mounted on the top and bottom edges. Turning the bottom roller brings a drawing taped to the belt closer to the front of the board, providing approximately twice as much usable drafting area as the conventional drawing table of equivalent dimensions. The belt tends to return to its original shape as soon as pressure from a pen, pencil or compass point is relieved. It has good light-reflecting qualities; provides a positive hold for a compass point; resists most chemicals, abrasion, wear and moisture; and can be cleaned with a damp cloth. Drafting tape adheres well and is easily removed. A reference table, two drawers, two book shelves and a





THE PROBLEM

DESIGNING FOR LOWER INSTALLATION COSTS

A design engineer wanted to incorporate a manually controlled trip odometer into an automobile speedometer assembly. When it came to designing the control linkage between the knob and the odometer, he was faced with the problem of selecting a method which would be economical both from the standpoint of materials and from the standpoint of easy installation. That's why he chose –

THE LOW-COST SOLUTION

AN S.S.WHITE REMOTE CONTROL FLEXIBLE SHAFT

The adaptability of the flexible shaft control allowed the speedometer to be properly positioned on the dashboard and the odometer reset knob to be placed where the user could readily operate it. Furthermore, the use of the shaft eliminated time-consuming alignment problems – *resulting in important savings in assembly time and costs* – and what is equally important, contributed to a design which adequately met customer acceptance.

It will pay *you* to investigate the cost-reducing possibilities of using S.S.White flexible shafts on your own remote control applications.

Here's Important Design Information

The 256-page Flexible Shaft Handbook has full details on how to select and apply flexible shafts. A copy will be sent free if you write for it direct to us *on your business letterhead.*

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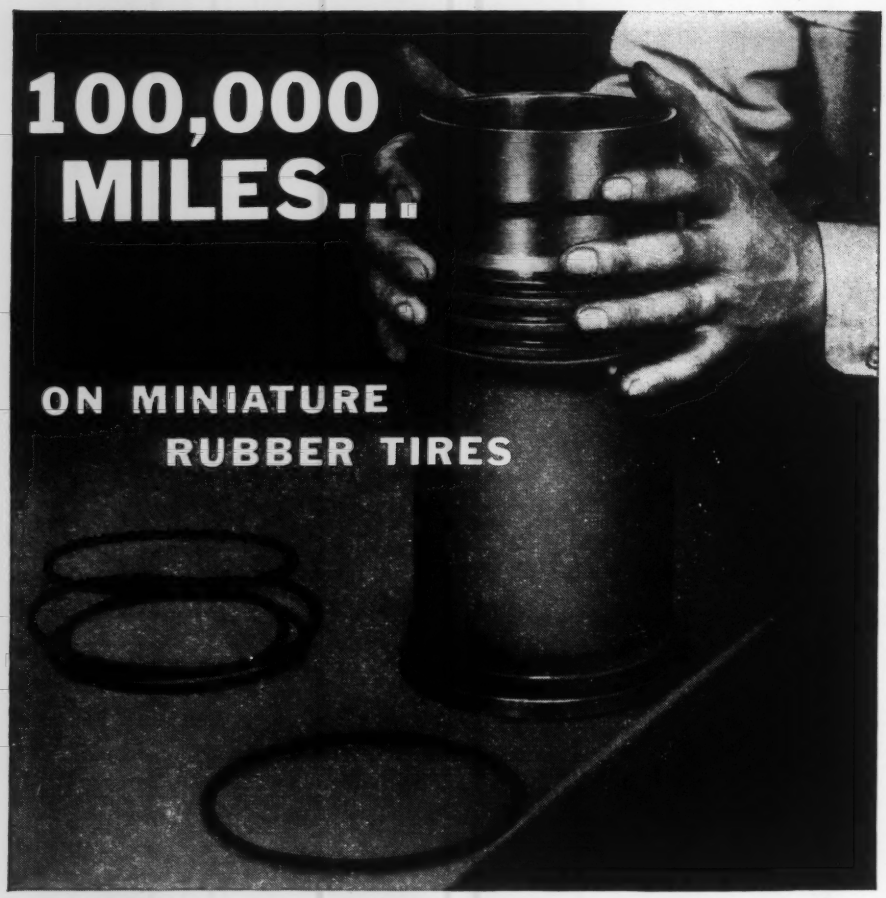

Photograph courtesy of
Cummins Engine Company, Inc., Columbus, Indiana

Tire-shaped rubber packing rings for cylinder liners in Cummins diesel engines are small but important. They provide a seal between oil and water—a seal that must be perfect whether the engine is cold or operating at high temperatures. Moreover, these rubber rings must stand up for at least the equivalent of 100,000 miles of operation.

These severe operating requirements presented a rubber problem with exacting specifications: resistance to sustained heat—controlled swell in oil—exceptional compression quality—precision tolerances.

Continental met all these specifications and produced a rubber ring that gives outstanding service in an outstanding diesel engine.

The successful production of this specialized rubber part is typical of the complete service in rubber offered by Continental.

When *you* need molded or extruded rubber parts, why not enlist the assistance of Continental?

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This new engineering catalog lists hundreds of standard grommets, bushings, rings and extruded shapes. It will be a valuable addition to your working file. Send for your copy today or . . .

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Cincinnati, Ohio	Indianapolis, Ind.	Philadelphia, Pa.	Syracuse, N. Y.

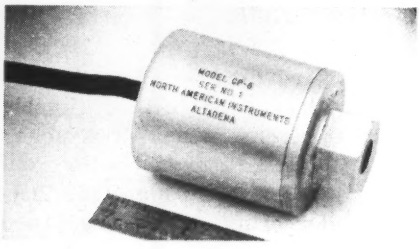
Engineering Equipment

shelf for rolled or flat drawings are built into the rear of the table. The 36 x 60-in. drafting board is adjustable for height and slope and adaptable for drafting machine, parallel line attachment or T-square. Made by **Tecnibord Co.**, 85 South St., Boston 11, Mass.

For more data circle MD-125, Page 187

Pressure Transducer

Suitable for both static and dynamic measurements, model GP-8 pressure transducer has ranges extending from 200 to 5000 psi and is rated at 100 per cent safe overload. Natural frequency is from 2000 cycles per second at lowest range to 10,000 cycles per second at highest range. Unit resists mechanical vibration and shock excitation, and

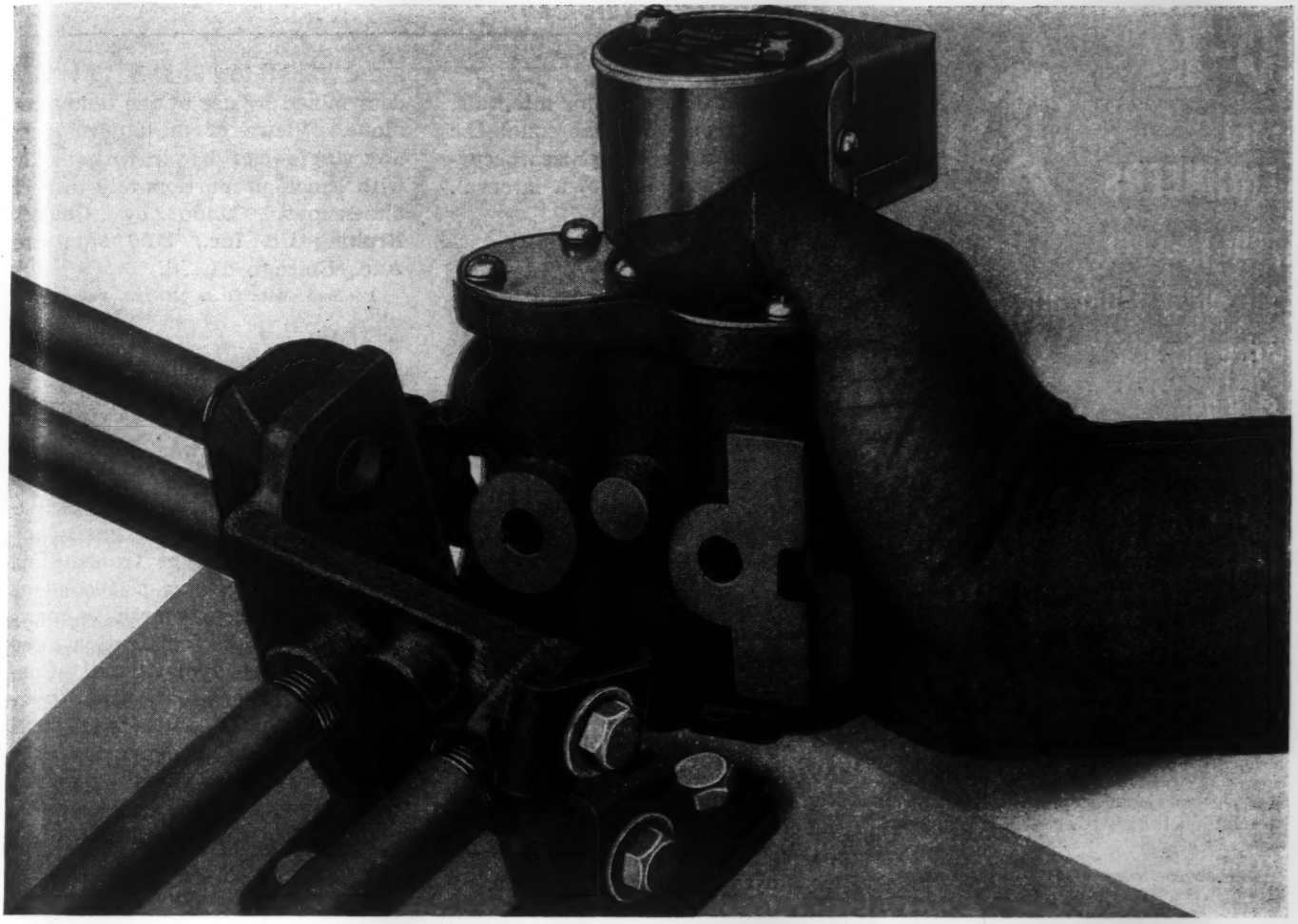


acceleration response in the most sensitive axis is less than 1 per cent full scale per 1000 *g* in all ranges above 1000 psi. Any excitation frequency from 60-50,000 cycles per second may be used, the maximum input voltage at 3000 cycles per second being 30 v. Full scale output is 40 mv per volt input in bridge circuit operation. Made by **North American Instruments Inc.**, 2420 N. Lake Ave., Altadena, Calif.

For more data circle MD-126, Page 187

Precision Timer

Model 432 interval timer measures short time intervals in the ranges of 0.01 to 9.99, 0.1 to 99.9 and 1 to 999 milliseconds. It also serves as a high-speed totalizing counter, with a count capacity of 999, and as a secondary frequency standard with outputs of 100 kc, 10 kc, 1 kc, 100 cps, 10 cps and



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Long operating life, free from valve maintenance and solenoid trouble, is the only true basis for evaluating valve cost.

CRESCENT VALVES* have emerged as champion, time after time, wherever an accurate comparison test was conducted under actual operating conditions. Not laboratory tests, but careful comparative studies by valve users—and now Crescent customers. If you are a user of 4-way, 3-way, or shut-off Solenoid air valves, Crescent Valves will save you money; we invite comparison on your own application.

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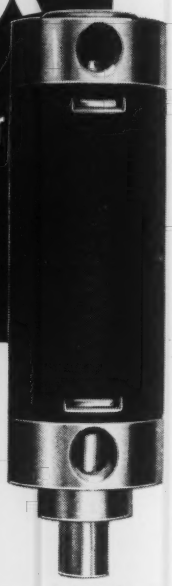

The technical training, experience, and resourcefulness of O-M Field Engineers is available to any manufacturer who has an Air or Hydraulic application problem.

In many cases, the recommendations of these specialists result in improved design, more efficient machine performance and economies in production.

The O-M Field Engineer in your area would welcome an opportunity to discuss your Air and Hydraulic applications with you on an engineering level, in your plant. Simply contact any of the O-M Representatives listed in this advertisement or mail the coupon below. No obligation, of course.

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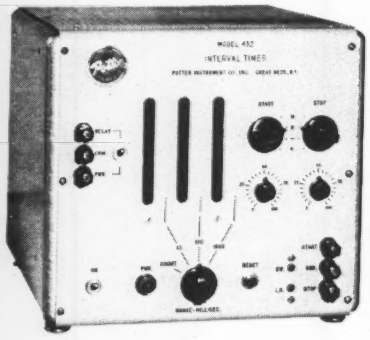
Engineering Equipment

1 cps. In measuring time intervals, three electronic decades count the number of time-base pulses occurring during the unknown interval.

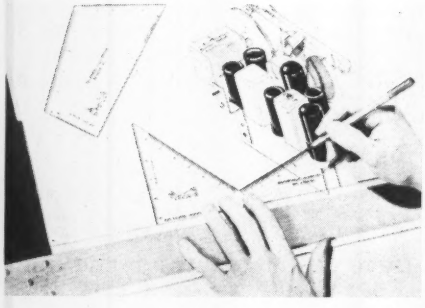


Time-base frequencies of 100, 10 and 1 kc are provided, and all time-base signals originate in a 100-kc crystal-controlled oscillator. Control can be by positive pulse, negative pulse, contact closure, contact opening, or any combination of these phenomena. Counters may be reset at the end of each interval measurement or allowed to accumulate a number of intervals for averaging. Made by **Potter Instrument Co. Inc.,** 115 Cutter Mill Rd., Great Neck, N. Y.

For more data circle MD-127, Page 187

Template Set

Five-piece template set for use in technical illustration work provides a uniform, positive system for determining dimensions of

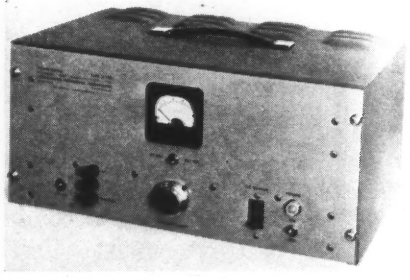


lines and angles in pictorial drawing without requiring involved projections, mathematical calculations, graphs or special boards. Curves, radii and ellipses can be determined by use of the templates alone. Views of an object from any angle can be drawn quickly with exact, proportionately correct dimensions. Made by **Charles Bruning Co. Inc.,** 4700 Montrose Ave., Chicago 41, Ill.

For more data circle MD-128, Page 187

Power Supply

Type 3-132 power supply furnishes 0 to 15 v dc at a maximum of 1 amp. Designed for the excitation of multiple strain gages and other resistance type transducers, it may be used as a secondary reference voltage source in many other research, calibration and measurement applications. Continuously adjustable output voltage is indicated on a front-panel meter and may be varied with a 10-turn voltage-setting control. Output impedance is less than 0.1-ohm; output drift, less than 5 mv per hour; ripple, less than 1 mv



peak-to-peak. Either the positive or negative output terminal may be grounded, or the output may "float" free of the chassis. A portion of the unit's high-gain circuit continually compares the output against a stable internal reference voltage to ensure absolute regulation. Terminals are also provided for the connection of an external reference. Self-contained in a metal carrying case which measures $8\frac{3}{4}$ x 11 x 19 in., the 45-lb unit may be operated from any 105 to 125-v, 50, 60 or 400-cycle line. Standard rack type mounting is also possible. Made by **Consolidated Engineering Corp.,** 300 N. Sierra Madre Villa, Pasadena 15, Calif.

For more data circle MD-129, Page 187

THE ENGINEER'S

Library

Recent Books

ASME Handbook—Metals Properties. *Edited by Samuel L. Hoyt, metallurgical consultant, Battelle Memorial Institute; 454 pages, 7 by 10 inches, clothbound; published by McGraw-Hill Book Co. Inc., New York; available from* MACHINE DESIGN, *$11.00 postpaid.*

A compilation of information on metallurgical, physical, fabrication and mechanical properties of typical metals, this reference book furnishes comprehensive data with comments necessary to characterize each material and typify its uses for the guidance of the designer. More than 500 ferrous and nonferrous metals in common industrial use are covered in convenient chart and table form.

Tabulated under each of the metals is such information as its chemical composition; its brittleness and heat treatment; its industrial uses; treatment temperatures for forging, annealing, quenching and hot working. Metals of like kind are grouped together and have been identified, in most instances, by the designations commonly used by the fabricating industries. A cross index is provided for further identification by other systems.

♦

Thermionic Valves—Their Theory and Design. *By A. H. W. Beck, Standard Telephones & Cables Ltd., London, Eng.; 588 pages, 5½ by 8½ inches, clothbound; available from Cambridge University Press, American Branch, 32 E. 57th St., New York 22, N. Y., $12.00 per copy.*

This book gives a theoretical account of the behavior of thermionic high vacuum electronic devices. The volume is divided in three parts, the first dealing with the physical theory of thermionic, secondary, field and photoelectric

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...eliminate **SHOCK...**

...reduce **NOISE...**

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Robinson Mounts with the exclusive wire-mesh, resilient cushioning material, Met-L-Flex, completely lack the faults and failings of old-fashioned mountings that employ rubber organic or synthetic materials, or depend solely upon springs. Robinson Mounts are inherently and permanently damped; they do not drift, pack down or wear out; they are unaffected by grease, oil, water, dust or extreme temperatures.

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emission and the phenomena of fluorescence and phosphorescense. Part 2 covers the mathematical theory of the fields set up by charged conductors and the resulting electron motions. The last part describes applications of the theory to various classes of electronic tubes.

♦

Statics and Strength of Materials. *By Roland H. Trathen, professor of mechanics, Rensselaer Polytechnic Institute;* 516 *pages,* 5½ *by* 9 *inches, clothbound; published by John Wiley & Sons Inc., New York; available from* MACHINE DESIGN, $7.50 *postpaid.*

Assuming previous experience in mathematics and physics, this textbook presents principles of statics and strength of materials and indicates general methods of applying them to engineering problems. Extensive use is made of the free body concept. Care is taken in explaining sign conventions, and nomenclature conforms to the recommendations of the American Standards Associaton.

Following an introductory chapter on fundamental concepts, the next four chapters are concerned with bars, trusses, beams and circular bars under various load conditions. Chapters 6 and 7 discuss stress and strain at a point, combined stresses and stress-strain relations. The last seven chapters include theories of failure for members subjected to biaxial stresses, statically indeterminate structures, special beam problems, columns, dynamic and repeated loads, and forces in space.

♦

Differential Equations in Engineering Problems. *By Mario G. Salvadori, professor of civil engineering, and Ralph J. Schwarz, associate professor of electrical engineering, Columbia University;* 446 *pages,* 5¼ *by* 8¼ *inches, clothbound; published by Prentice-Hall Inc., New York; available from* MACHINE DESIGN, $8.65 *postpaid.*

Emphasizing a workable approach to the study of differential equations as applied to engineering problems, this textbook employs many practical examples to introduce new topics and techniques. A familiarity with calculus and algebra is assumed. The first two chapters provide background material. The next four chapters deal with linear equations with constant coefficients—the type of differential equation most likely to occur in engineering applications. The following three chapters are concerned with methods of handling certain types of linear equations with variable coefficients and some nonlinear equations. The use of Fourier series is covered in Chapter 10. The last chapter briefly introduces the solution of partial differential equations. Numerous illustrations supplement and clarify the text. Problems are also given to implement text discussions.

♦

Television Fundamentals. *By Kenneth Fowler and Harold B. Lippert, General Electric Co.;* 532 *pages,* 6 *by* 9 *inches, clothbound; published by McGraw-Hill Book Co. Inc.; available from* MACHINE DESIGN; $7.00 *postpaid.*

Each element of the television receiver system from the antenna to the picture tube is clearly discussed in this book. Basic electrical and electronic principles are thoroughly explained before the more complex circuitry and theory of television are covered. Since this volume is written primarily for the television technician, the use of difficult mathematical and engineering analyses is avoided.

♦

Procedures in Experimental Metallurgy. *By A. U. Seybolt and J. E. Burke, General Electric Company;* 352 *pages,* 5¾ *by* 9 *inches, clothbound; published by John Wiley & Sons Inc., New York; available from* MACHINE DESIGN, $7.00 *postpaid.*

Intended primarily for men working in the metallurgical and associated fields, this book describes most of the important laboratory techniques which are now used in the preparation of metals and alloy specimens for further

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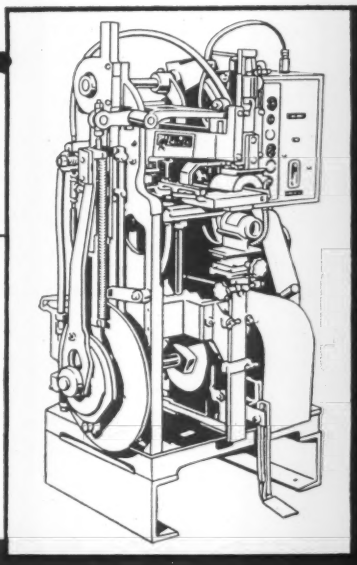

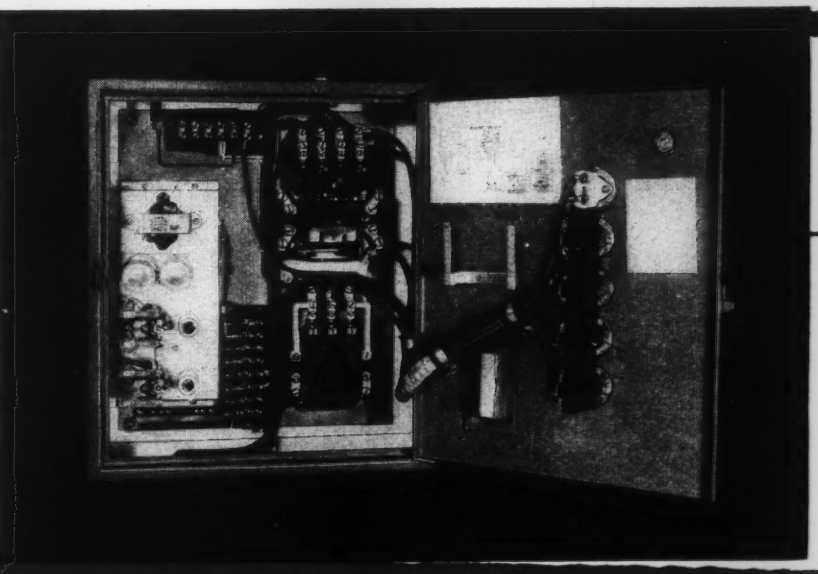

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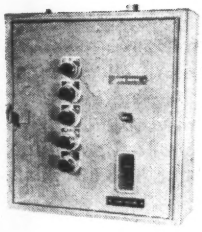

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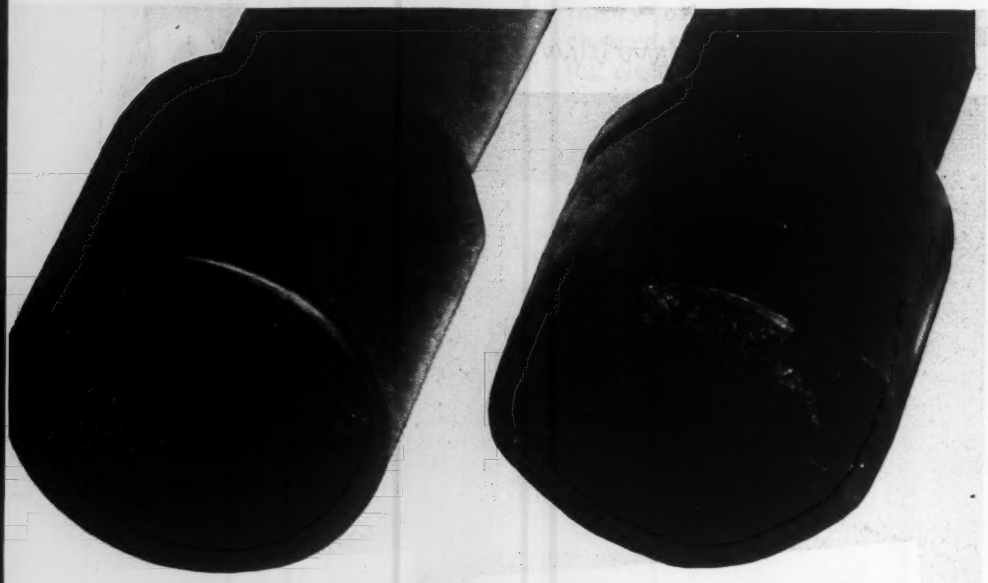

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study. Of interest to design engineers are several chapters which cover melting, casting, heat-treating techniques and fabrication of metals.

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Laboratory Instruments—Their Design and Application. *By A. Elliott, Courtaulds Ltd., and J. Home Dickson, Royal Naval Scientific Service, London, Eng.;* 414 *pages,* 5¼ *by* 8¼ *inches, clothbound; published by Chemical Publishing Co. Inc., New York; available from* MACHINE DESIGN, $7.50 *postpaid.*

This liberally illustrated volume serves as a practical laboratory instrument design guide. The first four chapters deal with properties of various materials and their treatment and use in the construction of instruments. Chapter 5 discusses the preparation of drawings. Succeeding chapters cover constrained motion; magnification of small displacements; sensitivity and errors; isolation from disturbing influences; damping; tests for straightness, flatness and squareness; glass and its working; lenses, mirrors and prisms; optical instruments and photography in research.

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Materials and Processes. *By James F. Young, General Electric Company;* 1088 *pages,* 5¾ *by* 9 *inches, clothbound; published by John Wiley & Sons Inc., New York; available from* MACHINE DESIGN, $8.50 *postpaid.*

A second edition, this reference book embraces a broad study of engineering materials and manufacturing processes. In two parts, Part I covers in fourteen chapters the nature of pure metals; alloys; metallographic examination; mechanical, corrosion, tarnishing, electrical and magnetic properties of metals; nonmetallic materials; electrical insulation; plastics; rubber; ceramics and miscellaneous nonmetallic materials. The second part, dealing with processes, contains ten chapters which discuss casting; powder metallurgy; heat treating; hot and cold working; welding and allied processes; ma-

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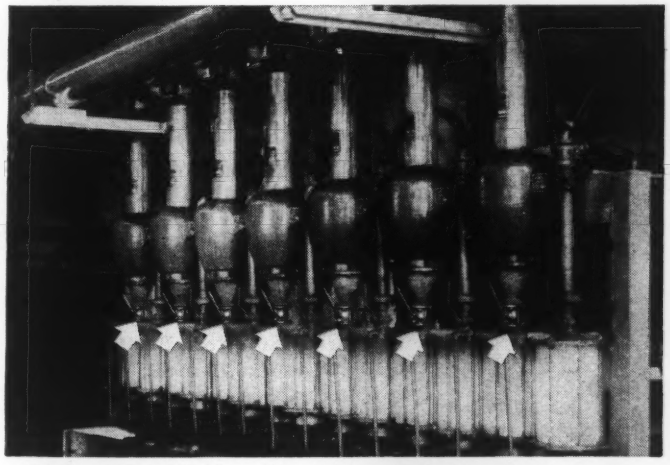

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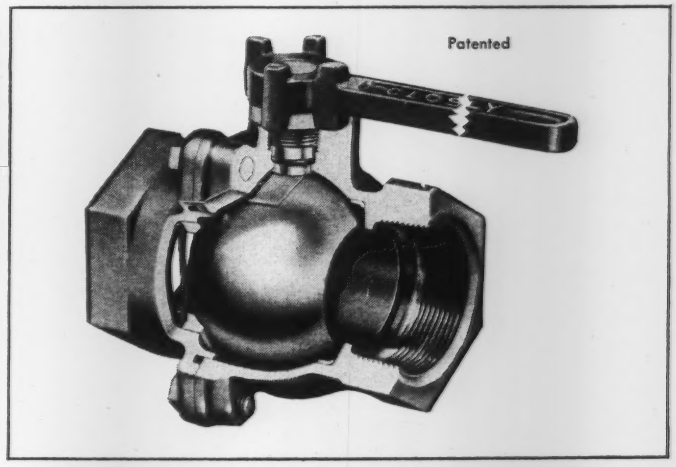

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Chambers's Shorter Six-Figure Mathematical Tables. *By L. J. Comrie, Scientific Computing Service Limited, London, Eng.;* 414 *pages,* 6½ *by* 9¾ *inches, clothbound; published by Chemical Publishing Co. Inc., New York; available from* MACHINE DESIGN, $6.50 *postpaid.*

This volume contains mathematical tables which are useful for general purposes requiring more than four-figure accuracy. Included are logarithms of numbers and trigonometric functions, circular or trigonometric functions in radians, exponential and hyperbolic functions, derivatives, integrals, series, physical constants and mathematical constants.

New Standards

Cast-Iron Screwed Drainage Fittings. *ASA B16.12-1953;* 16 *pages,* 8½ *by* 11 *inches, paperbound; available from American Society of Mechanical Engineers,* 29 *W.* 39*th St., New York* 18, *N. Y.,* $1.00 *per copy.*

This standard covers threaded cast-iron drainage fittings designed primarily for drainage systems using standard wall screw pipe. Illustrations of standard types of fittings are followed by tables of their dimensions. Included are definitions of size, marking, material, tolerance, threading, ribs and coating.

Association Publications

Proceedings of the National Electronics Conference—1953. 993 *pages,* 6 *by* 9 *inches, clothbound; available from National Electronics Conference,* 852 *E.* 83*rd St., Chicago* 19, *Ill.,* $5.00 *per copy.*

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Resistance Welding of Miscellaneous and Dissimilar Metals. 6 *pages,* 8½ by 11 *inches, paperbound; available from the Resistance Welder Manufacturers' Association,* 1900 *Arch St., Philadelphia* 3, *Pa.,* 10 *cents per copy.*

This bulletin, Number 19 of a series, covers information on the spot, seam and flash welding of titanium, cobalt-base alloys and refractory metals, as well as zinc and zinc die castings, lead and lead alloys and dissimilar metals.

Government Publications

NACA Technical Series. *Each publication is* 8 *by* 10½ *inches, paperbound, side-stapled; copies available from National Advisory Committee for Aeronautics,* 1924 *F St., N. W., Washington* 25, *D. C.*

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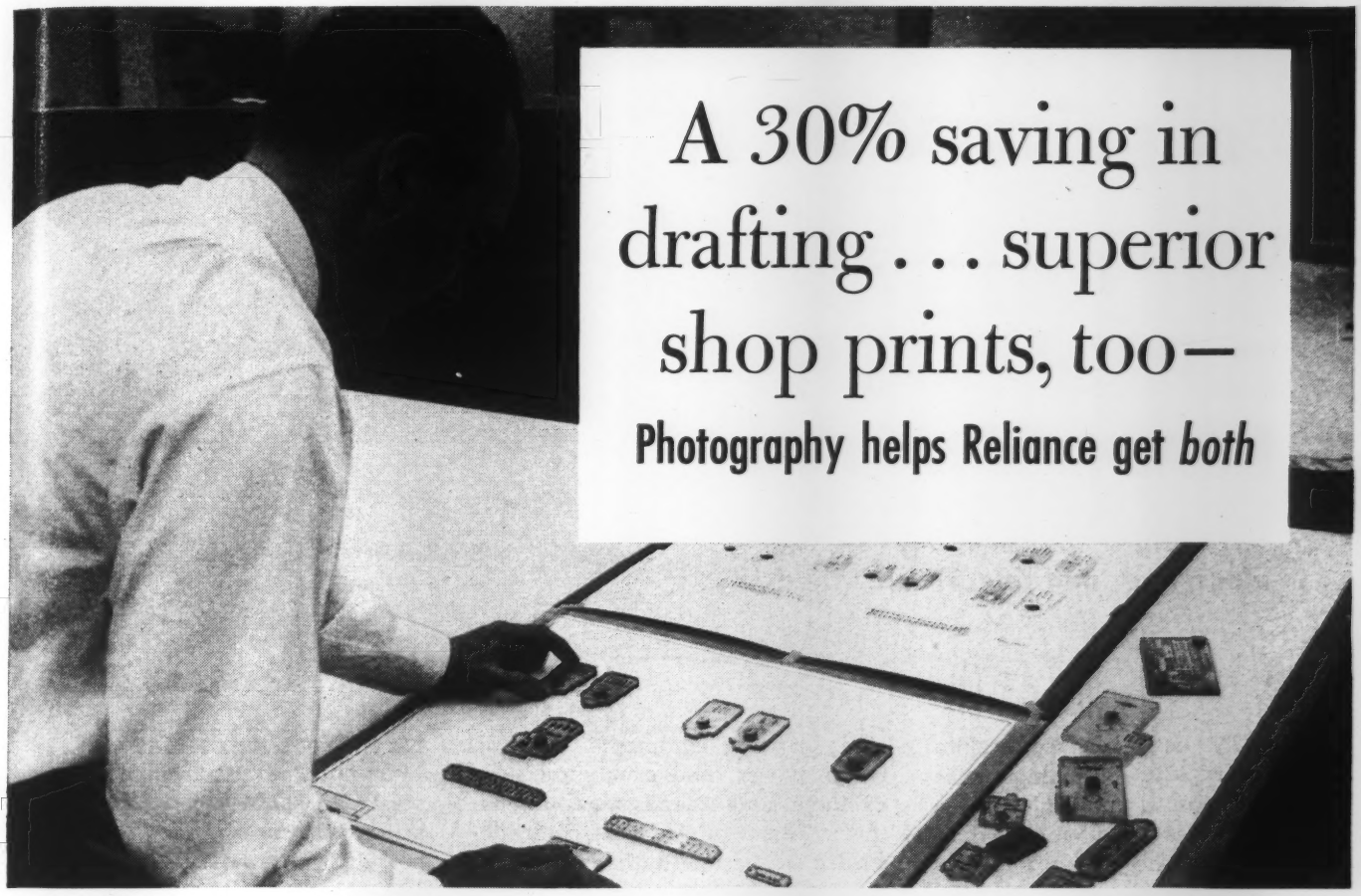

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Design Properties of MAGNESIUM

DESIGN ABSTRACTS

Light weight, ease of fabrication and other favorable characteristics of magnesium offer a wide range of application possibilities in design, particularly in the electrical and electronic fields

By Ralph G. Gillespie
Brooks & Perkins Inc.
Detroit, Mich.

DESIGN uses for magnesium are rapidly becoming more numerous. For a number of years magnesium has been employed to advantage in the design of electronic equipment used by the Armed Forces. Much of this equipment must be carried by soldiers, much is airborne, and magnesium is ideal for meeting the severe weight limitations encountered.

Many of the characteristics of magnesium have also made it useful in commercial equipment of all types, and it is now readily available in many forms. This metal is widely employed for enclosure of portable electrical appliances such as small motors, portable electric tools, vacuum cleaners, projectors and dictating machines. The following discussion details some of the more important considerations when applying magnesium in design.

Weight: The best known property of magnesium is its light weight. The specific gravity of magnesium is 1.76, while aluminum weighs 1½ times as much and steel 4.4 times. This weight factor is important in military electronic equipment such as FM radios *Fig.* 1, and other portable communications equipment including teletypewriters, plotting equipment, field telephone switchboards, etc. The latest gun director fire-control systems have radar lenses and reflectors; plotting equipment; control, servo, power, and events recorder cabinets; and other cases and housings. This equipment is often designed with numerous cast and machined magnesium parts to reduce weight to a minimum, *Fig.* 2.

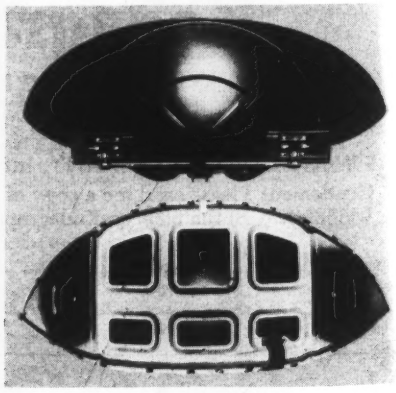
The factor of lightness combined with the good dimensional stability of magnesium often reduces vibration and other irregularities when parts are rotating at high speed.

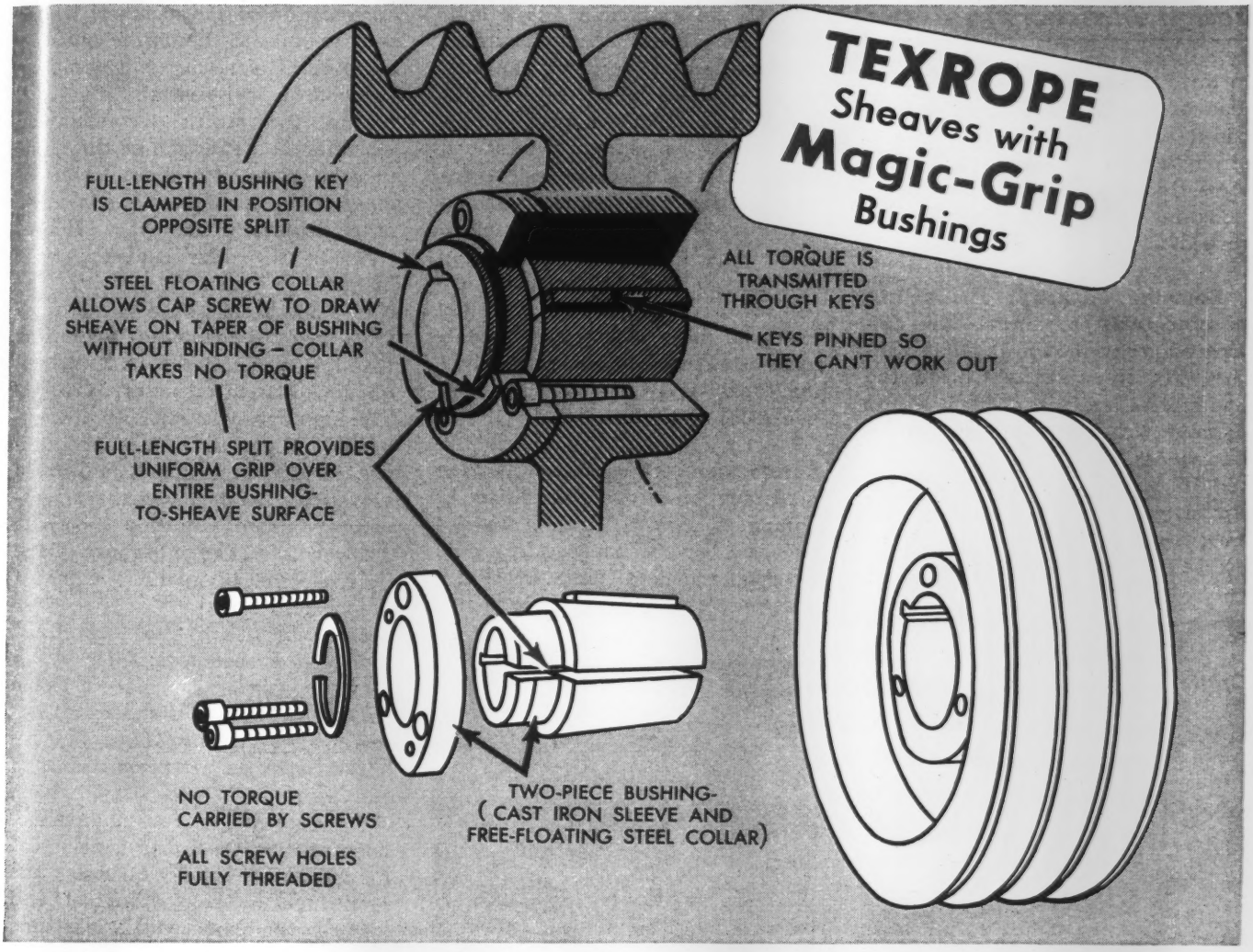
Stiffness: Modulus of elasticity for magnesium is 6,500,000 psi; aluminum is 10,000,000 psi and steel, 29,000,000 psi. Magnesium stiffness increases as the cube of section thickness. For an equal size cross-section, magnesium has somewhat less stiffness than the other two metals previously mentioned. For equal weights, however, the stiffness of magnesium is 8.19 times that of aluminum and 18.9 times that of steel.

Fig. 1—Case of new U. S. Army Signal Corps FM radio set is made of die-cast magnesium. Whole unit weighs only 6½ pounds

Resilience: Because of their low modulus of elasticity, magnesium alloys have a relatively high resilience. Resilience is the capacity of a material for shock absorption within the elastic range. It increases in direct proportion to the square of the stress applied, and

Fig. 2—Rear views showing construction techniques employed in design of 8-foot wide submarine search radar reflectors made of magnesium





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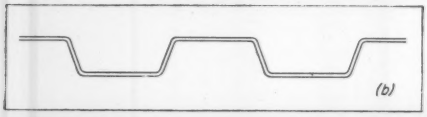
in inverse proportion to the modulus of elasticity. Energy values based on one-half the yield strength, a customary design stress, are significant for applications in which energy to be absorbed is known in advance.

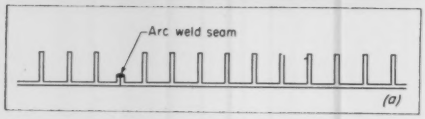
Damping Capacity: The ability of a material to absorb and dissipate energy into heat when subjected to cyclic stresses below the endurance limit is defined as its damping capacity. This characteristic is also referred to as internal friction or mechanical hysteresis. The damping capacity of magnesium alloys has been found to be substantially greater than that of the aluminum alloys and, for equal fiber stresses, much greater than the damping capacity of steel. This relatively higher damping capacity of magnesium alloys tends to prevent vibrations from building up to a serious intensity and, hence, reduces stresses and increases endurance strength. There are indications that alloy and temper have considerable effect upon damping capacity. For example, annealed temper AZ31X magnesium sheet has higher damping capacity than hard-rolled temper AZ31X sheet.

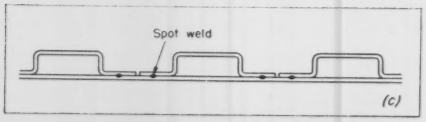
Effects of Vibration: Vibration occurring in structural parts of equipment may be of the resonant type, or may be imposed by cyclic external impulses. Both types are governed by the natural frequency of vibration of the member, which is a function of the design and the modulus of elasticity and damping capacity of the material.

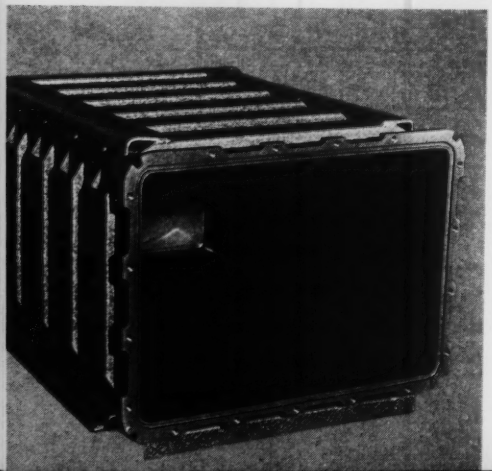
Since the natural frequency of vibration is a function of the modulus of elasticity, it is lower in magnesium members than in most other structural materials. Hence, there is a greater chance that a magnesium member, during the time operating speed increases from zero to maximum, will pass through a period of natural frequency, causing resonant vibration. The high damping capacity of magnesium tends to reduce the amplitude of both resonant and forced vibration. Above room temperatures resonant vibration occurs in a lower speed range because of the decrease in the modulus value of magnesium alloys.

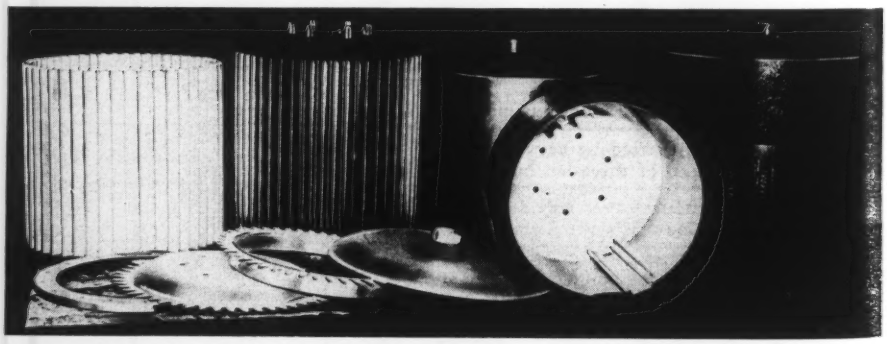
If a vibration of fixed amplitude is imposed upon a member by an external force, such as periodic shocks or other intended or unintended cyclic impulses, the resultant stresses are proportional to the modulus of elasticity, which, of course, is low for magnesium. Also, the high damping capacity of magnesium rapidly reduces the amplitude of free vibration and absorbs the shock within less time











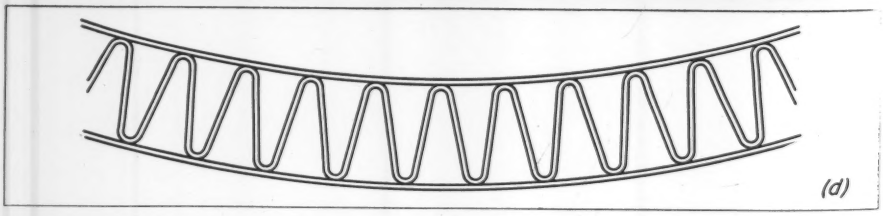
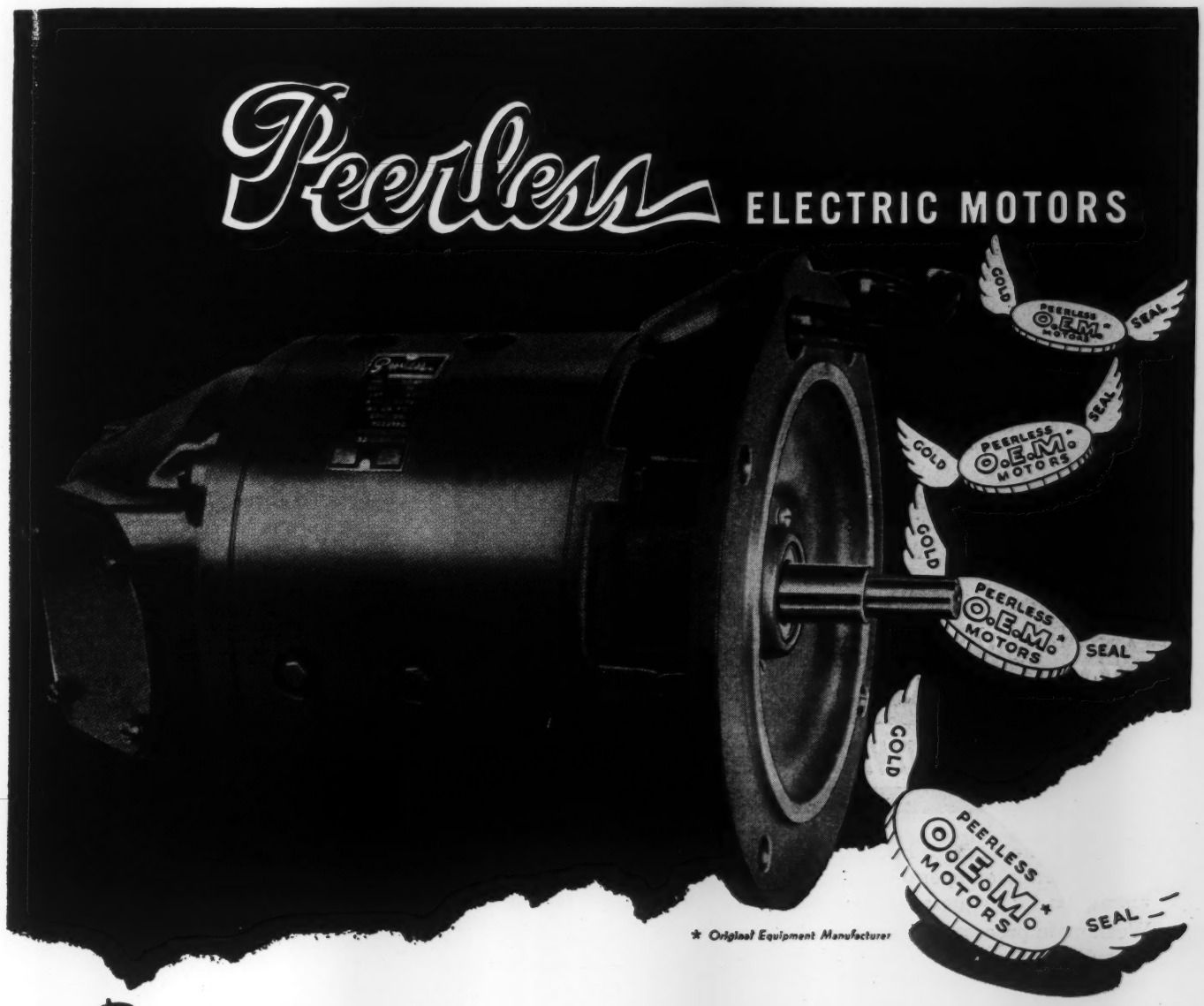


Fig. 3—Fabricating methods for magnesium pressurized containers for electronic equipment showing all extrusions, *a*; corrugated sheets, *b*; sheets with welded extrusions, *c*; and three sheet metal cans with middle can corrugated, *d*

Peerless ELECTRIC MOTORS



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Ralph Krohle
President

Peerless Electric

THE PEERLESS ELECTRIC COMPANY

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MOTORS FANS BLOWERS

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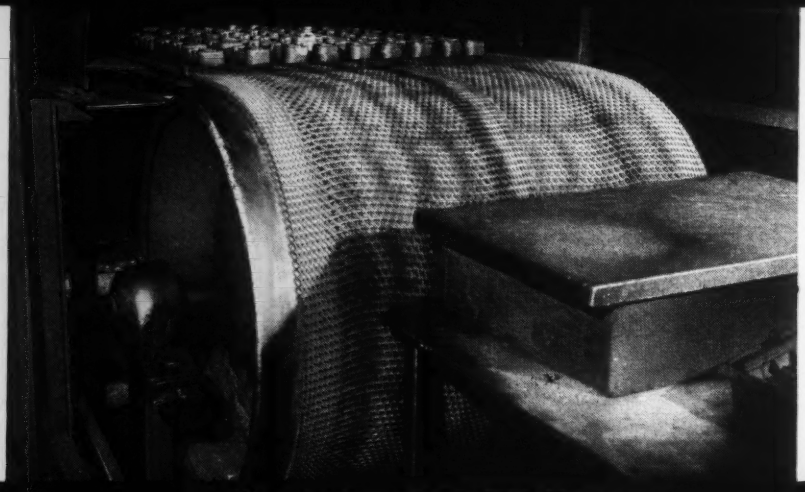

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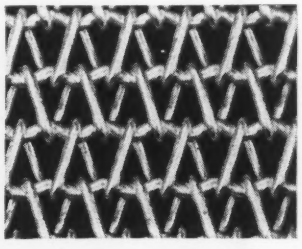

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Design Abstracts

than in metal with lower damping capacity.

Acoustic Properties: Magnesium alloys, because of their light weight and low modulus of elasticity, tend to reflect less sound than heavier, more rigid materials. In equipment where sound is produced by a forced oscillation, as in the disks in automobile horns which are operated by a fluctuating magnetic field, the low mass and low modulus of elasticity of magnesium result in a high amplitude of vibration for a given impressed force. The effect of damping here is to lead to a more diffuse tuning.

Thermal Conductivity: Although thermal conductivity of magnesium alloys varies somewhat with the alloy, it is several times as great as that of steel and slightly less than the conductivity of aluminum alloys. The problem of heat transfer from a ferrous or copper alloy insert to the surrounding magnesium housing, which occurs in electric motors, illustrates the possibilities of using magnesium because of its thermal conductivity. Whereas an iron housing would have to be joined mechanically, a magnesium alloy housing may be cast around the insert, improving the bond and reducing the temperature of the insert.

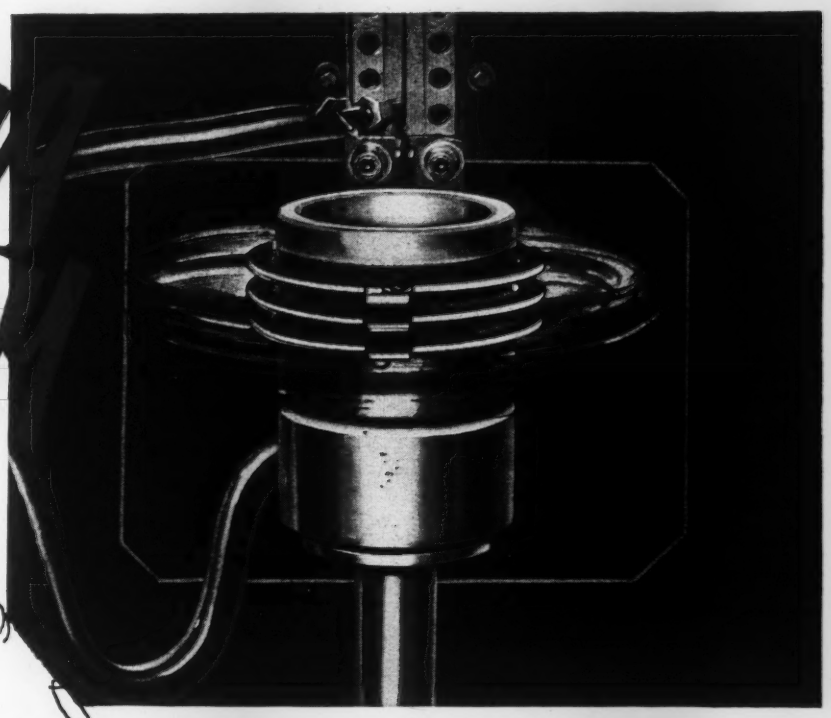
The slightly lower volume conductivity of magnesium alloys, as compared to aluminum, is an asset in electric spot welding because it makes possible the spot welding of greater thicknesses with equipment of a given power capacity, or of equal thicknesses with equipment of smaller current density.

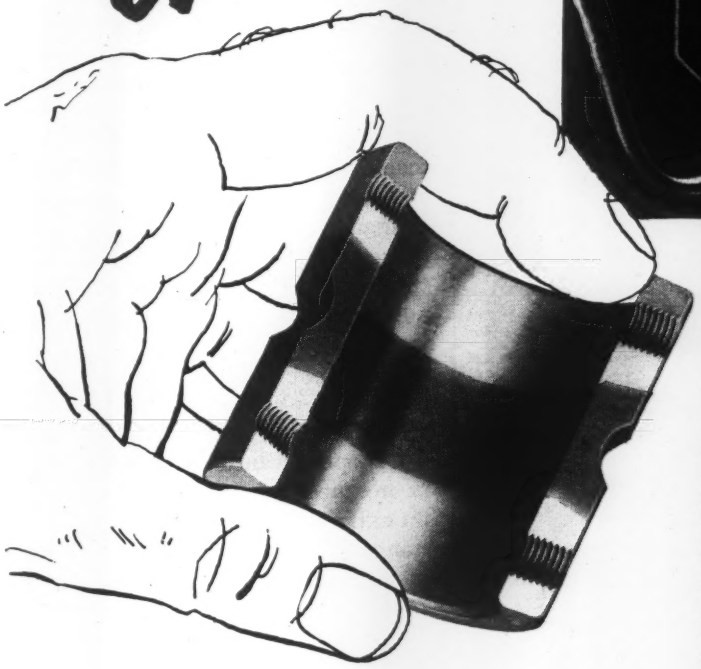
Magnesium's excellent thermal conductivity is responsible in part for its extensive use in rectifiers. Magnesium-copper sulphide rectifiers are widely used in welders and plating power equipment.

Magnetic Properties: Magnesium is nonmagnetic. It is used for cases to carry navigational compasses and similar instruments.

Weldability: Magnesium alloys can be welded by gas, inert-gas

Blazing the wa





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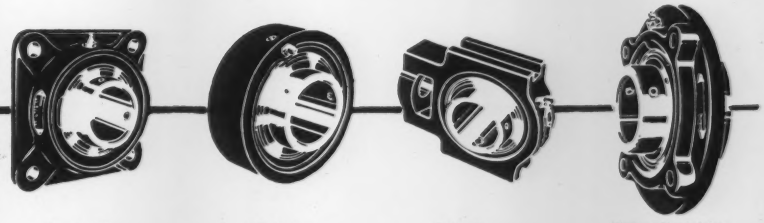

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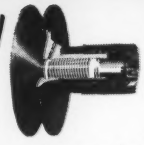

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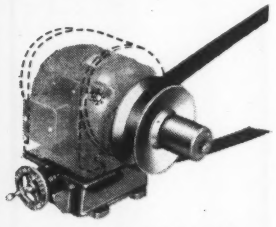

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Design Abstracts

shielded arc, and resistance welding. Arc welding usually produces sounder welds in magnesium than are possible with aluminum. Equipment such as pressurized containers, *Fig.* 3, for high altitude applications are increasingly being designed from magnesium; such air-seal cans usually are of arc-welded construction. The freedom of welded magnesium sheet and plate from microporosity, along with a corresponding relatively high weld strength, make these forms particularly useful for such applications.

Machinability: The high machining speeds obtainable with magnesium, the lower power required for machining, and the uniformly smooth finish obtained without dragging or tearing all combine to make machining of magnesium a relatively low cost operation. In addition to this, magnesium castings are generally free from hard spots, pinholes and other porosity which would result in greater scrap loss.

Of special interest to designers is magnesium's ability to acquire an extremely fine finish. It is often unnecessary to grind or polish magnesium to obtain a smooth surface. Surface smoothness readings of 3 to 5 microinches have been obtained with machined magnesium.

Drawability: Alloys of magnesium when hot can be drawn deeper than those of the other metals regardless of temperature used. They can be drawn from three to four times as deep in one operation as aluminum or steel. This property makes it practical to fabricate in one piece a part which, if made from other metals, might be fabricated by riveting or welding several pieces together. One-operation deep drawing also lends itself to more pleasing product design. Two other important advantages of single draws with magnesium are the elimination of all intermediate anneals, and the need for only one set of draw dies.

Grounding: To insure proper grounding of magnesium parts used in fittings or housings in air-

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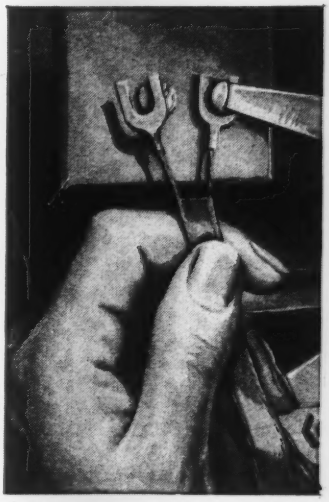

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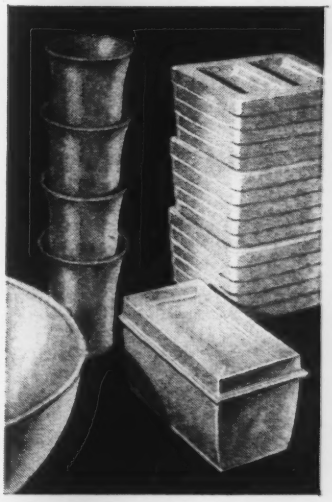

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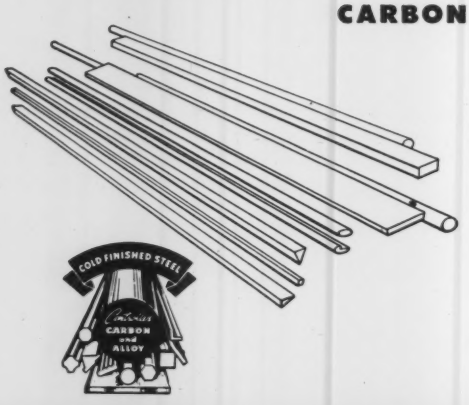

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Design Abstracts

craft electrical systems and prevent joint corrosion, composite copper-aluminum inserts are used in which the aluminum portion faces the magnesium part while the copper portion is joined to the grounded member. Grounding and attachment of wire connections to magnesium housings is usually mechanical. However, it may be accomplished by spot welding, as in magnesium batteries. Side wires are successfully attached to magnesium cells for pack assembly by either spot welding or soldering. The former method is generally preferred because of its simplicity and greater resistance to corrosion under high humidity conditions. The preferred wire for spot welding is stranded copper which is coated with zinc, tin, or solder, although uncoated copper is also satisfactory.

Corrosion: Many engineers hesitate to specify magnesium because they have heard that it corrodes rapidly. All metals will corrode under certain conditions. Even titanium, stainless steel, nickel, and other metals commonly considered corrosion resistant do corrode under proper conditions. These conditions differ with different metals. However, under almost all conditions carbon steels corrode many times as rapidly as do magnesium alloys.

Assembly Precautions: Because of magnesium's higher electrical potential when coupled with other metals in the presence of an electrolyte, galvanic corrosion can be serious if proper assembly precautions are not observed. Design consideration should be given to prevent this joint corrosion in assemblies, especially when dissimilar metals are involved and/or when moisture can be trapped and held between faying surfaces. Faying or contact surfaces should have two coats of zinc chromate primer on each surface when magnesium parts are assembled in contact with magnesium. Contact with dissimilar metals requires additional coats of primer plus a caulking compound. The protection of faying surfaces of magnesium alloy joints

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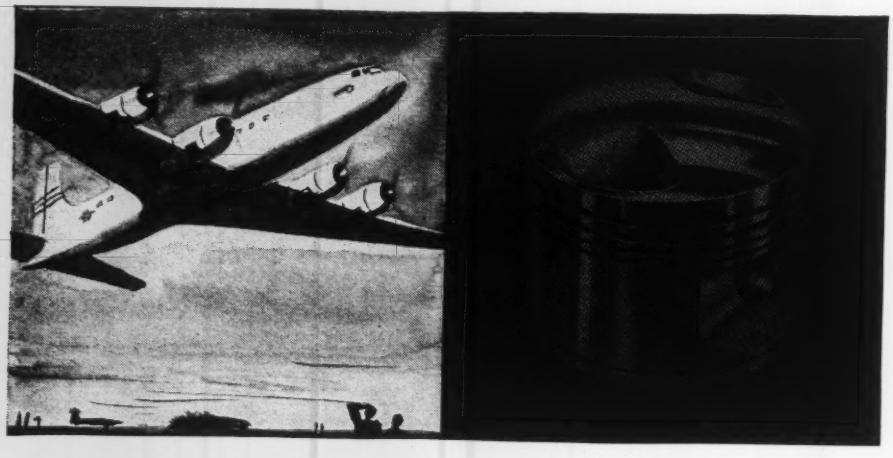

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Design Abstracts

and bimetal joints is described in government specifications (MIL-F-7179).

Most available mechanical fasteners are made either of steel or aluminum. In the case of aluminum rivets, the preferred alloy is 56-S. This aluminum alloy is electrolytically compatible with magnesium. If 56-S rivets are not readily available, 61-S or 52-S aluminum rivets may be used. Rivets made from 17-S, A-17-S, or 24-S should not be used with magnesium. Magnesium rivets are never used because they cannot be driven cold.

Proper practice with dissimilar metal fasteners includes the use of (1) anodized aluminum rivets, (2) zinc-plated or cadmium-plated steel, or anodized aluminum, bolts and washers, (3) rivets and bolts dipped in primer before inserting in some cases, (4) primed faying surfaces, and (5) proper final surface treatment and painting of the complete assembly.

Pickling and Finishing: The most commonly used prepaint pickle treatments are the chrome pickle (Dow #1) and the dichromate pickle (Dow #7). The chrome pickle is used on the M1 alloy, and also on other alloys, when an electrical conducting surface is required. The dichromate pickle is used on all alloys except M1 and gives a nonconductive surface.

Other treatments used include the HAE and Dow #17, both of which are electrolytic anodize type treatments which result in a ceramic type coating. Magnesium is also plated; wave guides and similar electronic equipment can be silver plated.

Almost all the paint systems used on electronic equipment made of other materials are applicable to magnesium. The proper finish can be recommended only after anticipated service conditions are known.

Electrical Appliance Applications: Magnesium is widely used as enclosures for portable electrical appliances. In March 1951, Underwriters Laboratories, Inc. issued Bulletin #45, *A Determination of the Acceptability of Magnesium Alloys as Enclosures for Portable*

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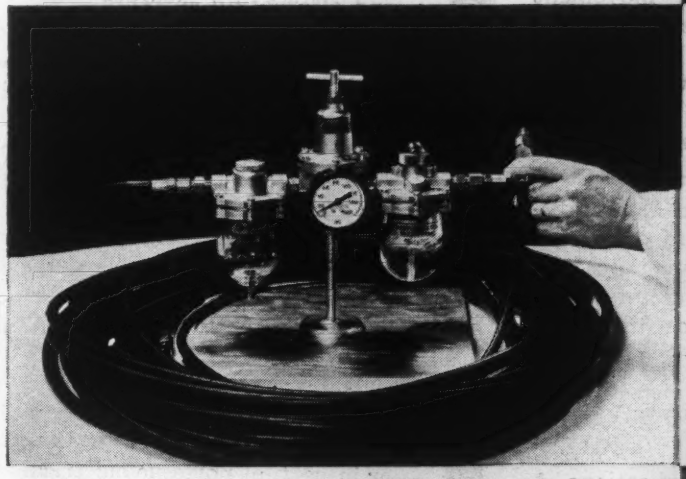

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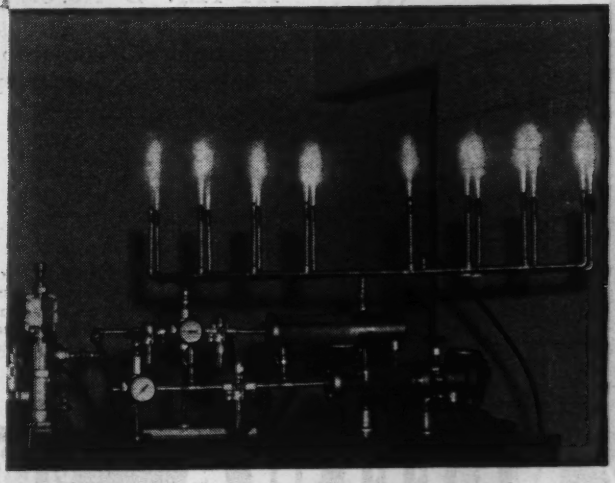

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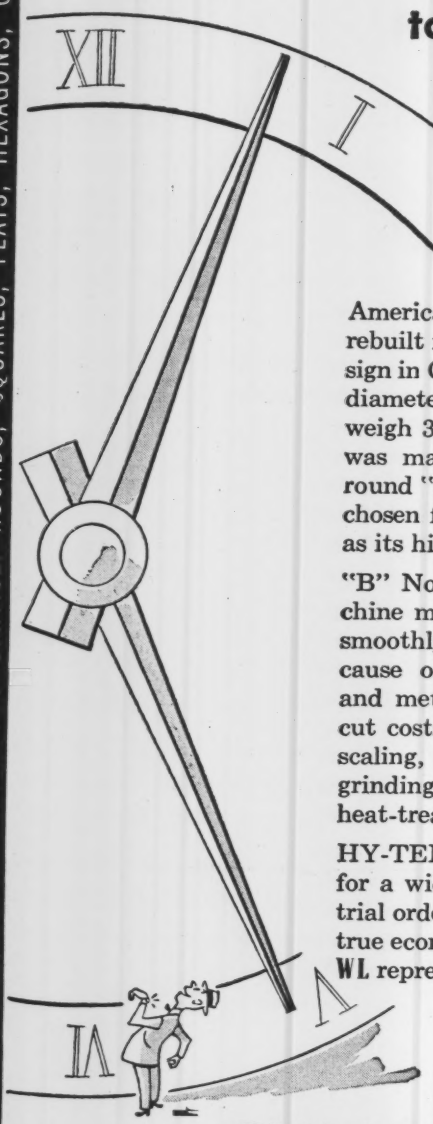

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Design Abstracts

Electrical Appliances. This bulletin states: "A general investigation was undertaken to evaluate the fire hazard involved in the use of magnesium alloys for portable electrical appliance enclosures. The assumption was made that an electrical failure would be accompanied by arcing, and that the resulting fire hazard might be increased by the presence of the magnesium alloy. Limited ranges of performance were investigated, utilizing carbon-to-magnesium and copper-to-magnesium arcs, on both direct and alternating currents.

"Certain recommendations for general use of untreated magnesium alloys were derived from the investigation. These limitations are judged to provide reasonable factors of safety for general design purposes. It is believed that in a specific appliance one or more of the limitations might be extended without increase in fire hazard.

"The magnesium-base alloys covered by this investigation are judged to have sufficient resistance to self-sustaining ignition to justify their use for enclosures, in whole or in part, of portable electrical appliances when all the following conditions are met:

1. The minimum thickness of the alloy used is 0.080-inch nominal (manufacturing tolerances permit 0.076-inch minimum for sheet).

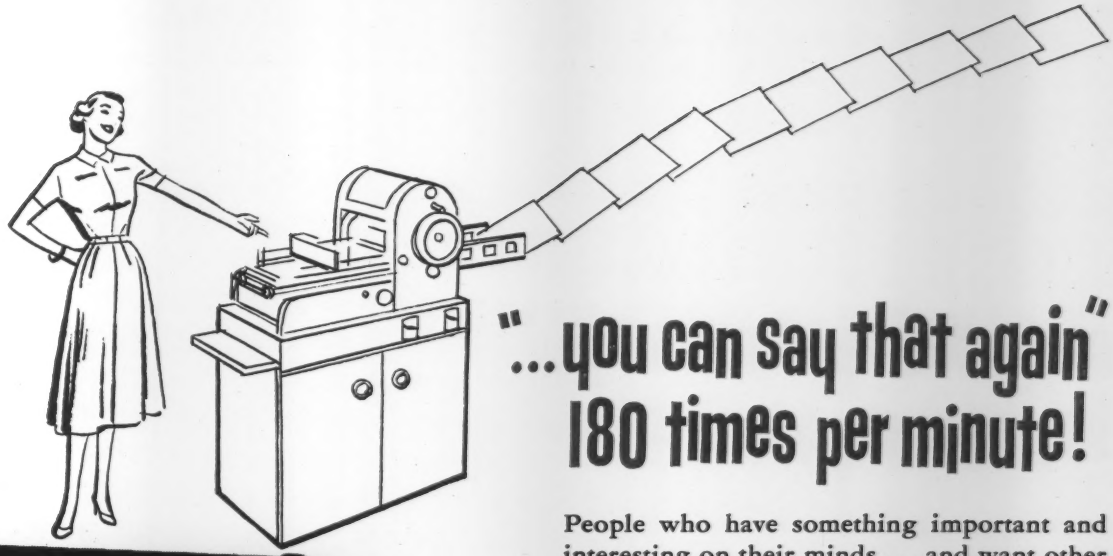
2. The appliance is provided with a flexible cord and plug and is designed for use only on 125-volt branch circuits rated at 30 amperes or less.

3. The appliance circuits are limited by design to 60-cycle alternating-current operation. (An appliance which produces direct current within the enclosure would require further investigation.)

4. The temperature of the magnesium alloy resulting from abnormal operation of the appliance is limited to 200 C.

5. Motor frames of cast magnesium alloy are limited to motor ratings of 1/20-horsepower. (Larger motors would require further investigation.)"

Conclusions: Magnesium has been used extensively for the past ten years for electrical applications



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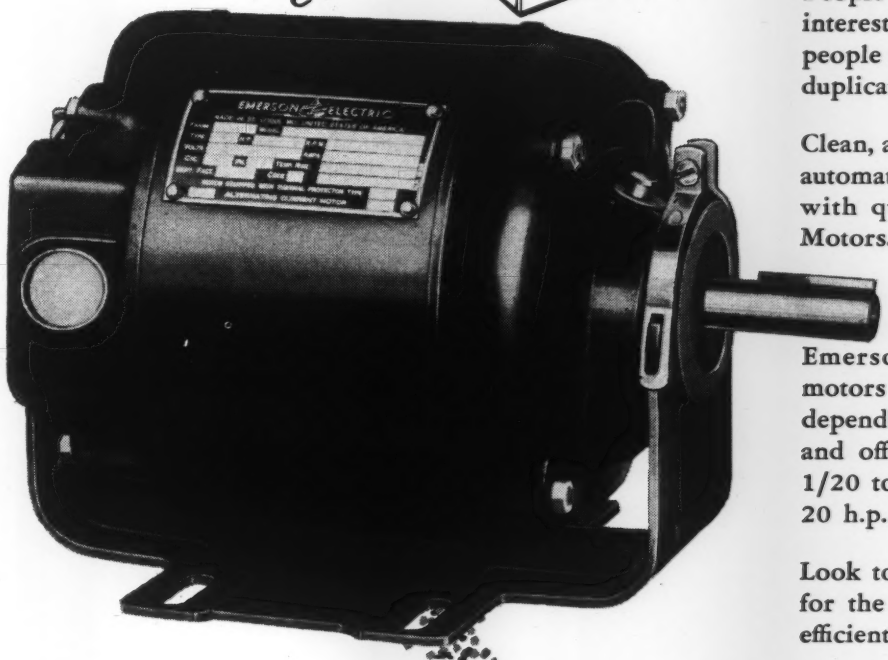
Clean, accurate copies—180 per minute—flow automatically from these machines, powered with quiet, dependable Emerson-Electric Motors.



Emerson-Electric specializes in building motors for equipment with a reputation for dependability. It has done so for 64 years, and offers standard motors in ratings from 1/20 to 5 h.p., and hermetic motors 1/8 to 20 h.p.

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Manufacturers requiring motors 1/20 to 5 h.p. can profitably use these reference guides. Specifications, construction and performance data are included for these motors:

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- ☐ M420-B Split-Phase
- ☐ M420-C Integral
- ☐ M420-D Fan-Duty
- ☐ M420-E Oil-Burner
- ☐ M420-F Jet Pump
- ☐ M420-G Blower

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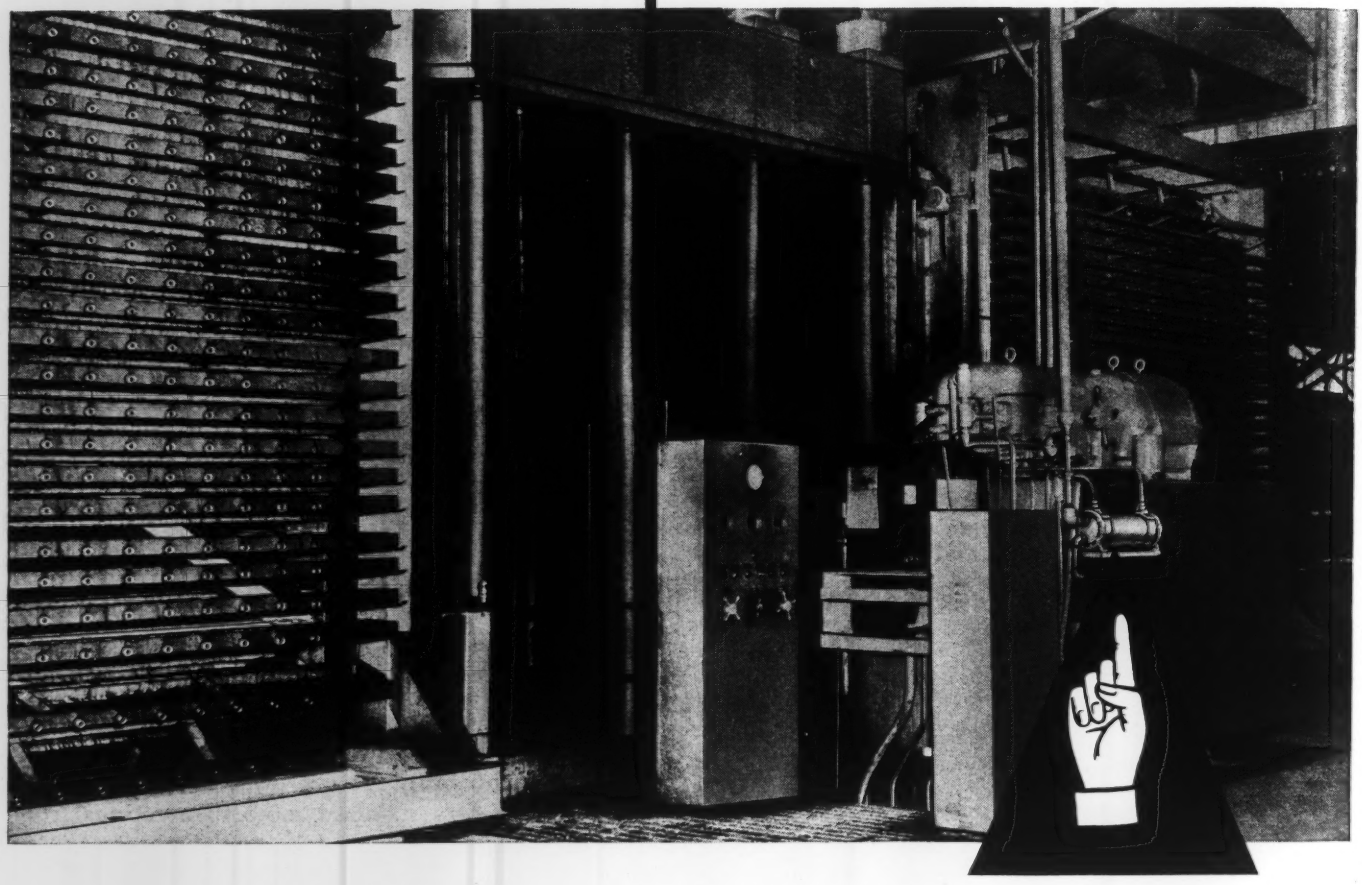
OIL KEEPS COOL | as hardboard sheets are formed between steam-heated platens



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by many of the country's largest electronic manufacturers and by the Armed Forces. It has properties which for certain electronics applications make it the best available material. With proper design and treatment, corrosion is much less of a problem with magnesium than with some other commonly used materials. Magnesium has proved suitable and economically practical, and has a record of satisfactory service in a wide range of electrical applications.

From an article entitled "Magnesium for Electronics and Electrical Applications" appearing in The Magazine of Magnesium *for February, 1954, published by Brooks & Perkins Inc.*

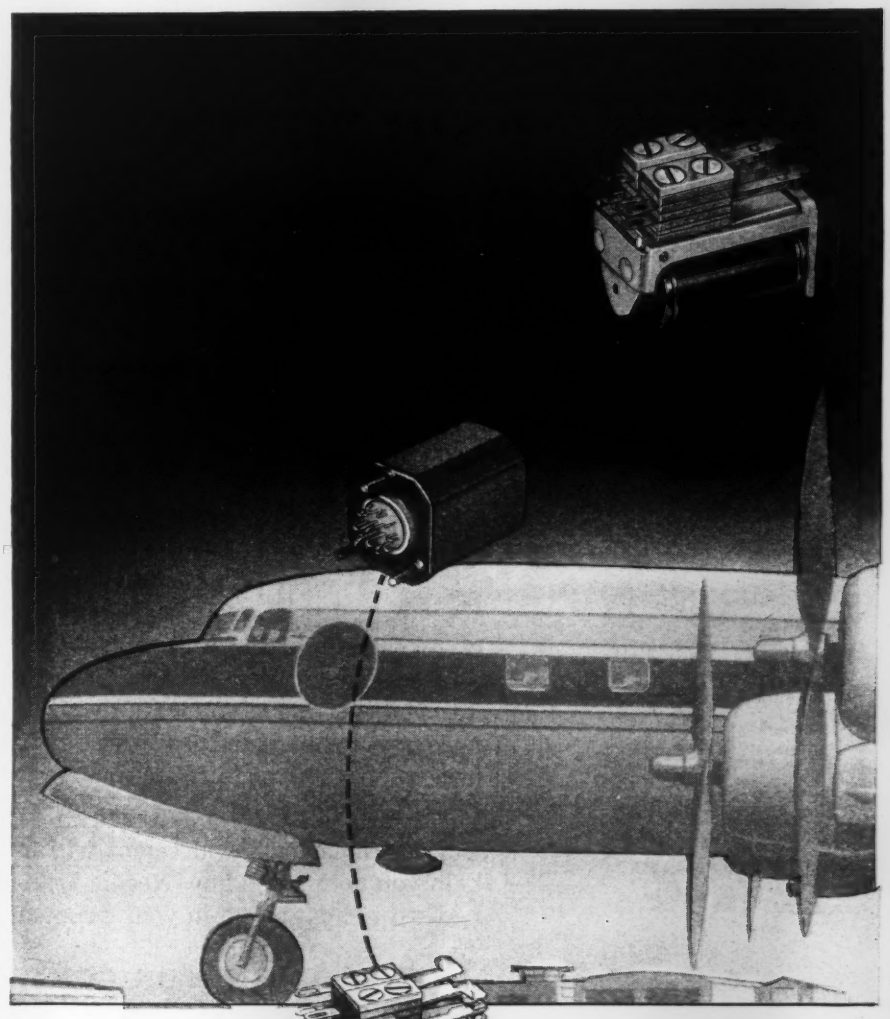
Today's Research and Tomorrow's World

By Vannevar Bush

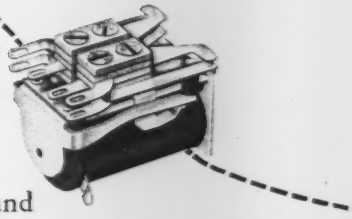
President
Carnegie Institute of Washington
Washington, D. C.

AS WE look forward in science there is plenty to do and plenty of fields for fresh accomplishment for organizations and men of vision whose support makes true progress possible. Let us not forget, however, that there is more to be done than just to pursue practical results which flow from the application of fundamental science. That science itself must be pushed ahead in every area in theoretical fields that are now so remote from application that no one can see any connection, in fields so abstruse that they cannot be successfully explained to laymen. For, unless we continuously restore the fund of basic knowledge, we shall ultimately exhaust it. And the greatest steps forward in the future rest on accomplishments of pure science which are now in infancy. Who in the early days of the century, when the theory of the atomic nucleus was being laboriously constructed, would have predicted that the practical results of an understanding of the atom would today be the

(*Continued on Page* 276)



COMAR SMALL SPACE RELAYS ARE BEST



Modern aircraft, communications apparatus and other control equipment requires components that combine efficiency with compactness and light weight. Comar's famous small-space relays meet this need. Very compact in size, yet rugged enough to withstand vibration, shock and temperature extremes, they are unsurpassed in performance and dependability.

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when you, too, use
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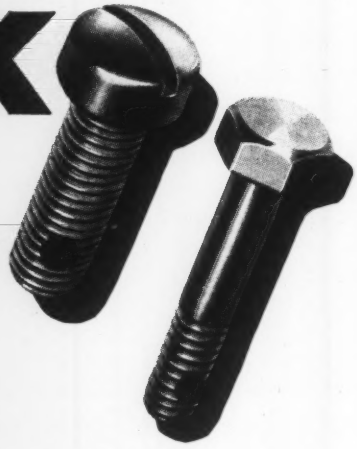
A hole in the head?

You don't need one when you use

NYLOK

ONE-PIECE

Self-locking bolts and screws that eliminate safety wiring . . .



Stop wasting time and money on intricate and complicated safety wiring! Use NYLOK self-locking screws and bolts. They lock themselves in any position, seated or unseated . . . no other parts needed. They assure positive, vibration-proof locking without galling, distortion or mutilation of threads or seating surfaces. The resilient nylon insert provides the wedge that locks. It's always there, can't be left out or forgotten and may be safely re-used many times.
So cut costly assembly time, eliminate extra safety-wiring labor and materials by using NYLOK self-locking screws and bolts. When you use NYLOK, you don't need drilled-head screws and bolts because NYLOK screws and bolts lock themselves!

● Let NYLOK engineers solve your fastening problems. Tell us about them and we'll show you how NYLOK will do the job faster, easier . . . and cheaper!

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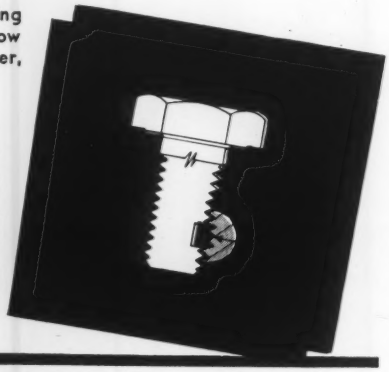
Resilient nylon plug (A) sets up lateral thrust, smoothly wedging mating threads together (B). All of locking action is on the threads; head is not stressed. Locking is positive, seated or unseated. Provides leak-proof seal where liquids are involved.



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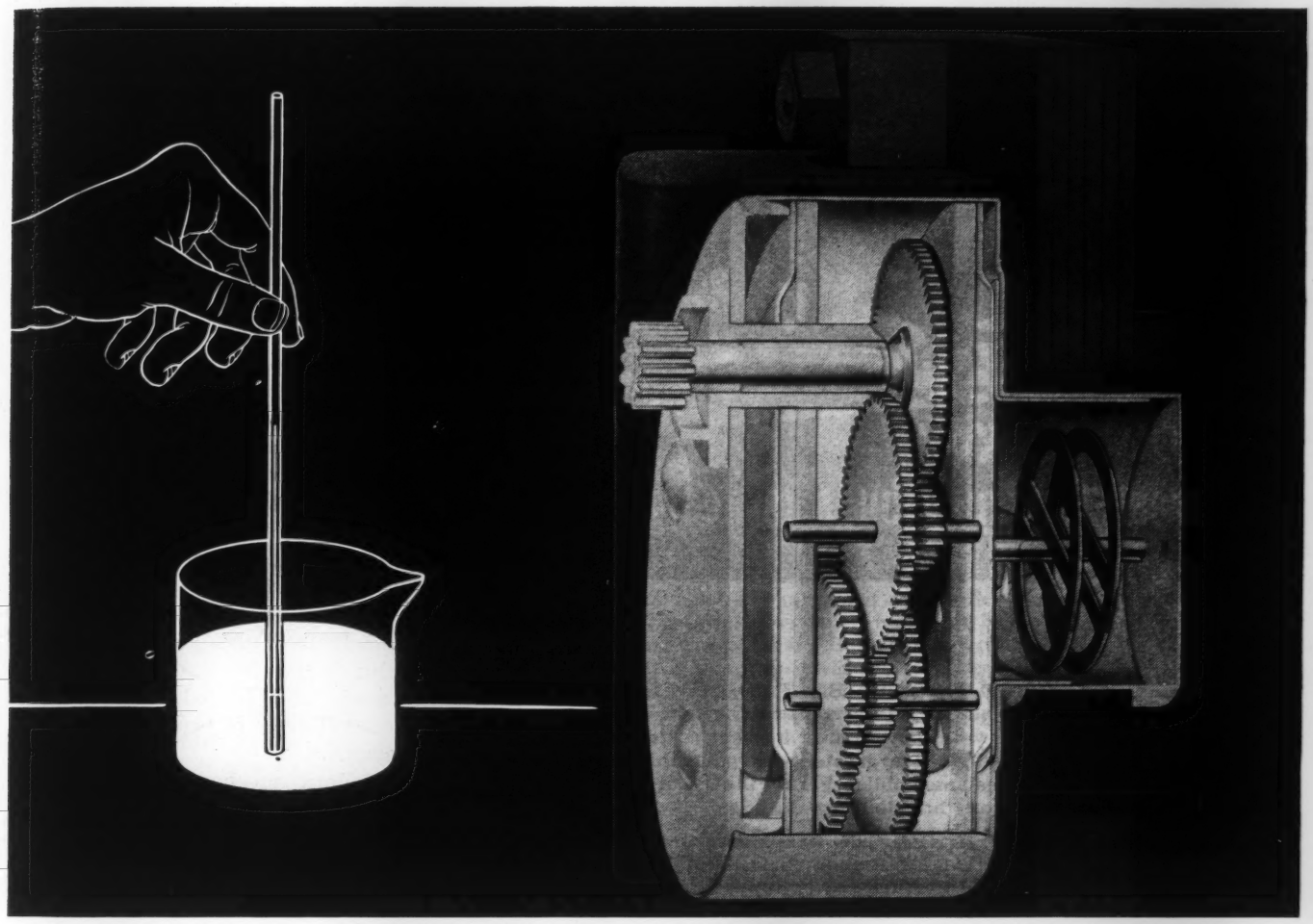
Design Abstracts

(*Continued from Page 273*)

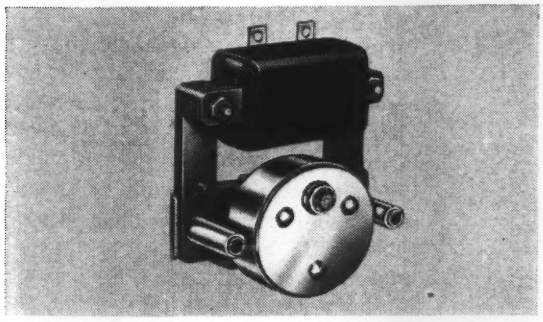
great dominating influence on our lives and plans? Who can predict what theory, today in the deep recesses of academic halls, may influence the lives of the next generation in comparable ways? As we pursue the fascinating trail of applying science, let us not neglect the foundation on which it rests.

The Machines' Role: There have been great strides in the development of machines for supplementing and substituting for human thought. Digital machines can perform hundreds of thousands of arithmetical manipulations per second, and by so doing can solve even abstruse partial differential equations. There is no reason why man should not relegate to the machine all those parts of his processes of cerebration which are repetitive in nature, or subject to exact formulation, thus freeing his mind for those processes which the human brain alone can encompass. The machine can manipulate, it can remember, and it can even learn by experience. But it cannot think in a complete sense. When the machine is joined to man's brain, which can guide it, the combination can perform feats of analysis that reach much farther into the unknown than can the unaided individual and far beyond what can be resolved by groups of men with conventional aids. The digital machine is on the peak of the wave of progress in analytical machinery, and the analog machines for the purpose are now to some extent over-shadowed by new developments.

But this process of supplementing man's mind by the machine needs to go much further than this if we are to cope with the complexities of the world that is coming. Civilization proceeds because man can store, transmit, and consult the record, because the accomplishments of one generation are available to the next, and because every man can share the experience of his fellows. A great surge forward came when Gutenberg introduced movable type. Modern methods of printing will soon move beyond the use of metal type and be-



MORE evidence of the extra VALUE in TELECHRON timing motors . . .



Lubrication is only part of the Telechron motor story. Lightweight rotors assure quick starting. Gears are hobbed for quiet operation. Power-line accuracy means true synchronous performance. Separation of the field from the rotor results in cooler operation and longer life.

The accurate, dependable, inexpensive Telechron Synchronous Motor is the heart of timing you see everywhere . . . in clock-radios, washers and dryers; in heating controls, refrigerator defrosters and air conditioners . . . in industrial time switches, recorders and instrumentation.

CAPILLARY ACTION FEEDS OIL TO MOVING PARTS

One secret of the lasting accuracy of a Telechron timing motor is its exclusive sealed-in system of lubrication.

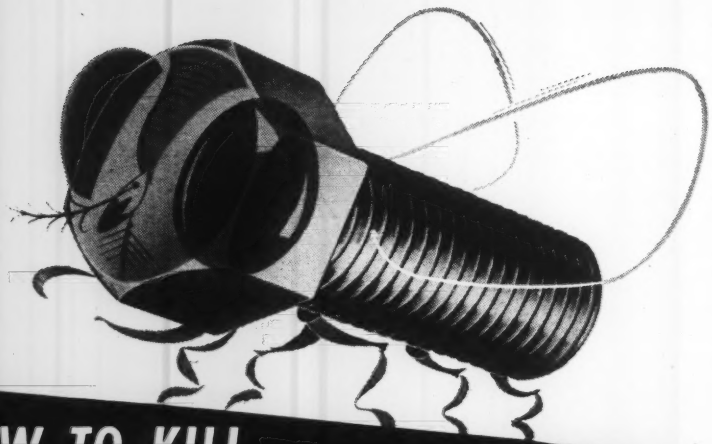
Each Telechron motor carries just the right amount of oil, locked-in against dirt and dust. The oil is drawn up the spaces between bearings and capillary plates by the same free-flowing process that pulls water up the hollow stem of a plant—or a glass tube. Bearings are constantly covered with a thin coating of oil.

This way the oil lasts the life of the motor—which, with a Telechron timing motor, can be for years and years.

Write for complete catalog and full information on our Application Engineering Service. Telechron Department, General Electric Company, 26 Homer Avenue, Ashland, Mass.

Telechron

MARK OF TIMING LEADERSHIP



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5 thread fastening bugs in design...

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***Heli-Coil* Inserts conform to official military standards MS-122076 (ASG) through MS-124850 (ASG) and others.**

Design Abstracts

come much more facile. Electrical means of communication, culminating in television, enhance the interchange of current thinking. Modern transportation by air brings men together over vast distances. But we are still in the horse-and-buggy stage in the ways in which we store and consult the record. It looks as though we were about to become buried in a mountain of printed scientific results, with no effective means of penetrating the mass to find the streak of ore that may be needed for further progress. No man can handle such masses of material by the methods of a generation ago. Scientists, perforce, become limited to the following of highly specialized trails only. Papers with results of genuine value are printed, stored, and buried. The conventional library is becoming an anachronism.

Modern mechanization and instrumentation can undoubtedly take us out of this morass. Electronic selection at high speed, microphotography carried to extremes now possible, facsimile transmission made rapid by television, and a dozen other techniques can solve the problem. Personally I believe the solution will involve storage and search by association of ideas, in much the same way as the human memory operates. But this great problem of modern methods of manipulating the scientific record is everyone's business, and no one's in particular. Its solution would involve large sums of money. This is particularly true since pilot-plant experimentation is difficult and expensive, by reason of the form of the existing record. It is perhaps too subtle a matter to be pursued by government, and too pioneering in nature. But it must be solved or we shall be in the fix of a colony of bacteria, bogged down, with all progress stopped by the burden of our own product.

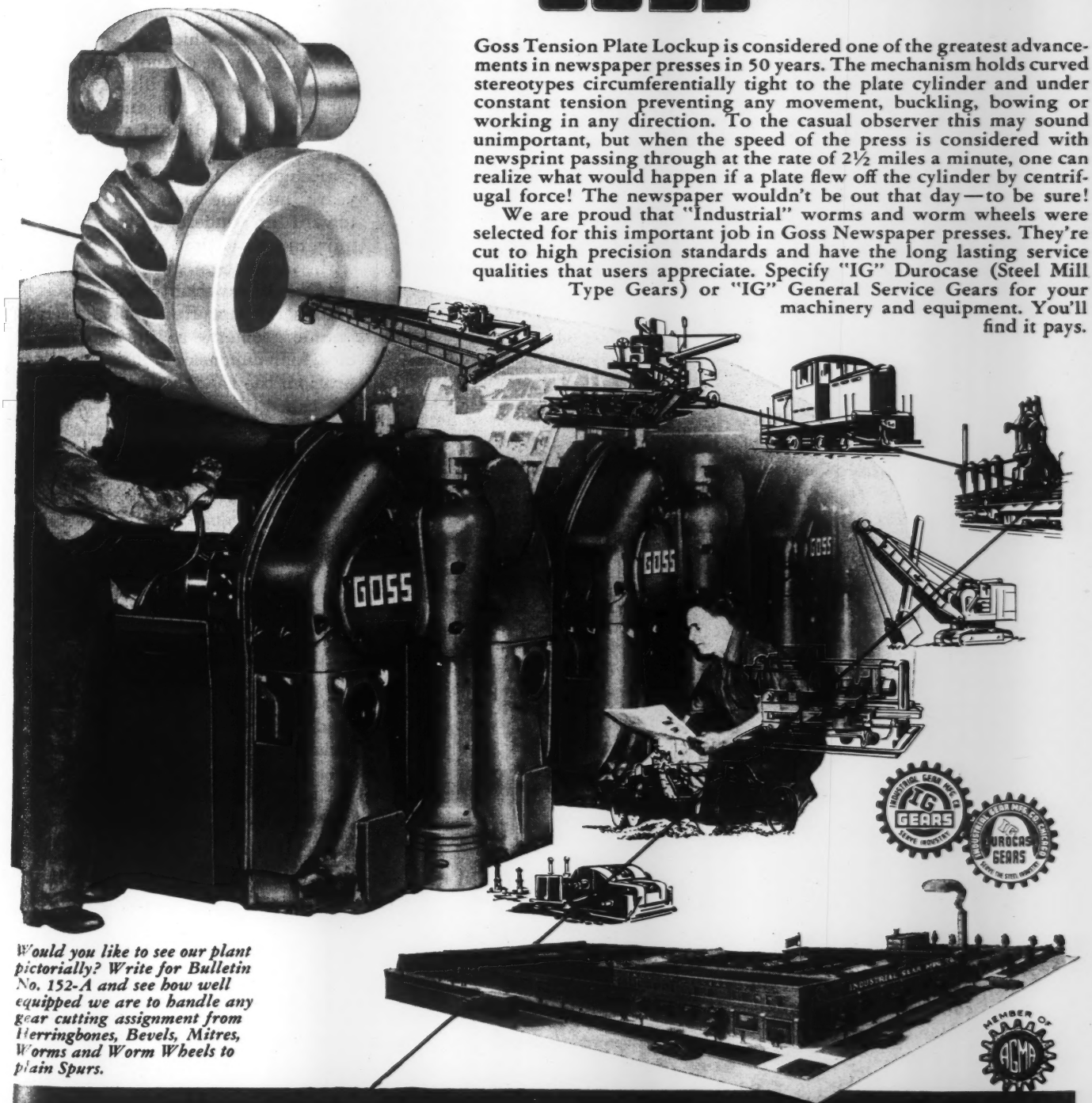
Motivation for Research: There is a reason for the search for knowledge which is inherent in the nature of man himself. The motivation which urges scientific men forward is the faith that it is good for man to understand, that this is

"Industrial Gear"

WORM AND WORM WHEELS ACTUATE THE PLATE LOCKING AND UNLOCKING MECHANISM ON GOSS HEADLINER PRESSES

Goss Tension Plate Lockup is considered one of the greatest advancements in newspaper presses in 50 years. The mechanism holds curved stereotypes circumferentially tight to the plate cylinder and under constant tension preventing any movement, buckling, bowing or working in any direction. To the casual observer this may sound unimportant, but when the speed of the press is considered with newsprint passing through at the rate of 2½ miles a minute, one can realize what would happen if a plate flew off the cylinder by centrifugal force! The newspaper wouldn't be out that day—to be sure!

We are proud that "Industrial" worms and worm wheels were selected for this important job in Goss Newspaper presses. They're cut to high precision standards and have the long lasting service qualities that users appreciate. Specify "IG" Durocase (Steel Mill Type Gears) or "IG" General Service Gears for your machinery and equipment. You'll find it pays.



Would you like to see our plant pictorially? Write for Bulletin No. 152-A and see how well equipped we are to handle any gear cutting assignment from Herringbones, Bevels, Mitres, Worms and Worm Wheels to plain Spurs.

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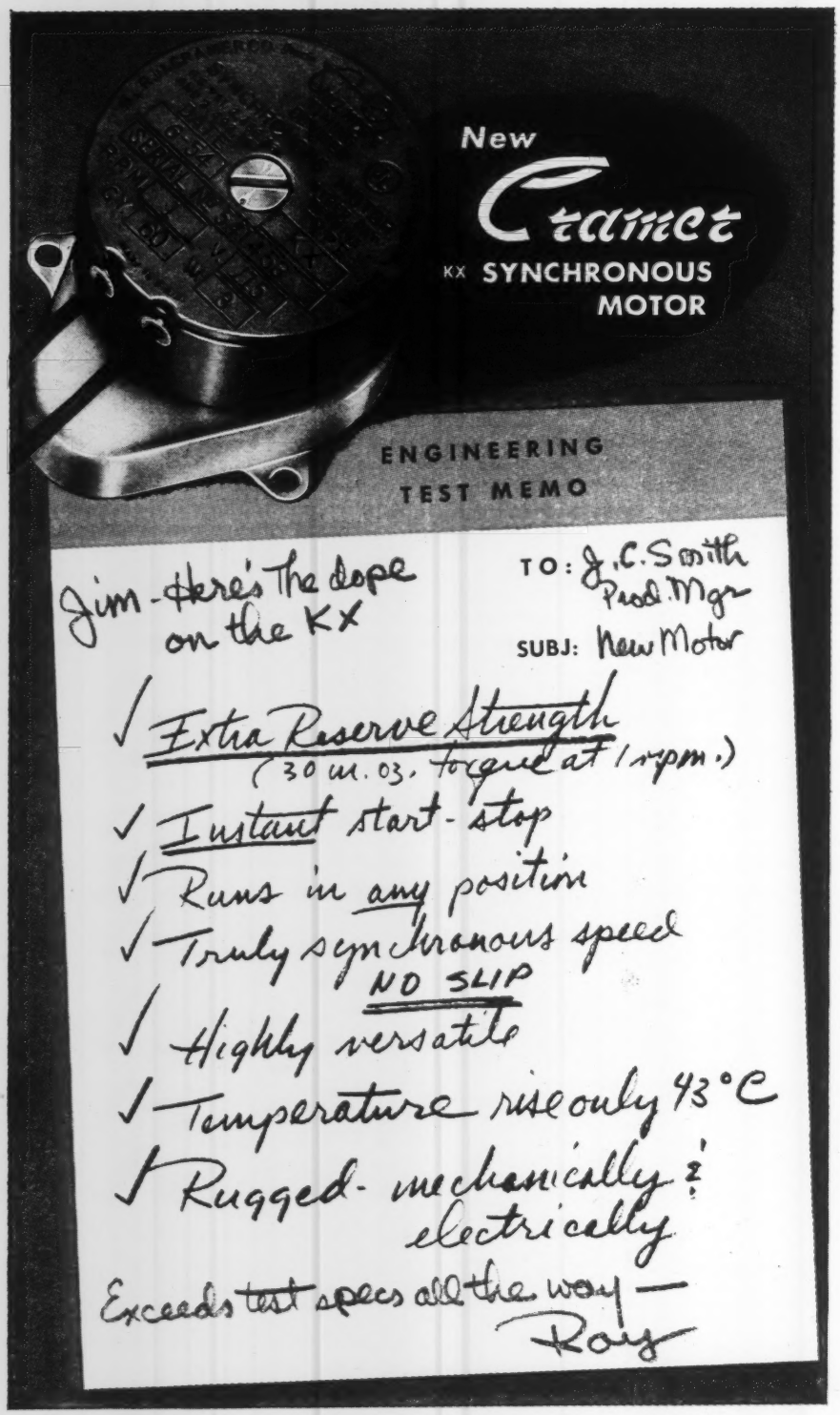

This does not tell the whole story by any means, but it does indicate the growing acceptance of this powerful motor for all types of instrument and control applications which require constant speed and dependability even under adverse environmental conditions. The complete story is yours for the asking. Write today.

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Design Abstracts

his mission. The human race is, from one point of view, an incidental excrescence in an enormous and heartless cosmos. We crawl upon a rock which hurtles through space, doomed to struggle with one another in accordance with an inexorable law of evolution, bound for extinction as the earth grows cold, unsung and unremembered, our greatest works but the meaningless scratching upon the walls of the prison in which we are confined. But there is another side to the coin. Man, in his dignity, looks out upon the cosmos and fathoms it. He examines distant galaxies by light which left them a half billion years ago. He traces several billion years into the past, and gropes toward an understanding of the universe as a time-space complex, with a strange geometry which renders it invariant to the point of observation. He constructs his cosmic geometry as the projection of a four-dimensional space configuration, the shadow of which alone he can grasp. He turns inward, breaks down his molecules to atoms, then to protons, neutrons, and electrons, watches and manipulates the alterations of these into new and strange entities of brief existence. He probes for the ultimate forces which control the form of the nucleus, and thereby control all matter. Moreover, he turns upon himself and examines the mechanisms by which nerves act, the mechanisms by which the brain itself remembers, combines, and controls. And as he does all this he marvels none the less at the great central fact of existence, that he as a consciousness which enables him to comprehend.

Ultimate Goal: It is good for man thus to search for understanding. His search will lead him into dangers, and he may not avoid them. But even disaster, a temporary reversal of the trend which we call progress, is preferable to the monotonous existence of a vegetable. We are embarked upon a great adventure, not of our own choosing or making. It holds perils, and the things we learn may dismay us. But there is a deep meaning to consciousness even if

Which Through-Hardening Grade of Alloy Tubing Is Best for You?

...B&W Can Supply Them All

For applications of mechanical tubing that require high strength, ductility, and resistance to impact, the medium-carbon, through-hardening steels are particularly suitable. A correlation of the properties of each available grade with your product specifications will help you determine the grade most suitable for your operation. Listed are the medium-carbon alloy steels typical of those that can be heat-treated to meet a broad range of mechanical properties. These steels all contain alloying elements introduced to provide a desirable combination of strength and ductility and to promote ease of heat treatment. In some grades the alloying elements also provide resistance to softening at higher tempering temperatures.

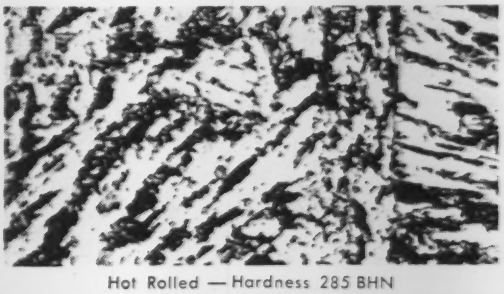
Tubing of these grades may be hot forged without difficulty by conventional methods, and in the softened state is readily machinable—a good indication of the workability common to all the medium carbon through hardening.

In the application of alloy tubing of these steels, it is often possible to use alternate grades without loss of desirable mechanical properties. You'll find Mr. Tubes—your link to B&W—always on call and invariably helpful in any discussion of your tubing requirements. You'll find B&W Bulletin TDC-141 helpful, too. Send for your copy today.

TYPICAL THROUGH-HARDENING GRADES

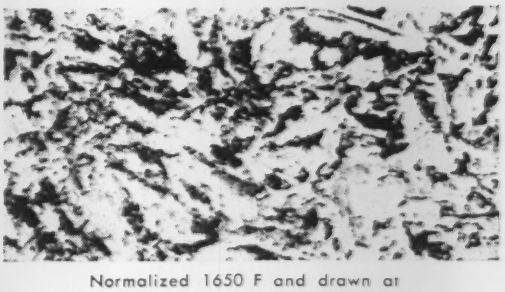
1340	2340	3140
4042	4140	4340
4640	5140	8640
8740	9440	

Typical Microstructures (at 1000 X) and Hardnesses, 4140 Steel



Hot Rolled — Hardness 285 BHN

Normalized 1650 F — Hardness 302 BHN



Normalized 1650 F and drawn at 1250 F for 1 hour — Hardness 217 BHN

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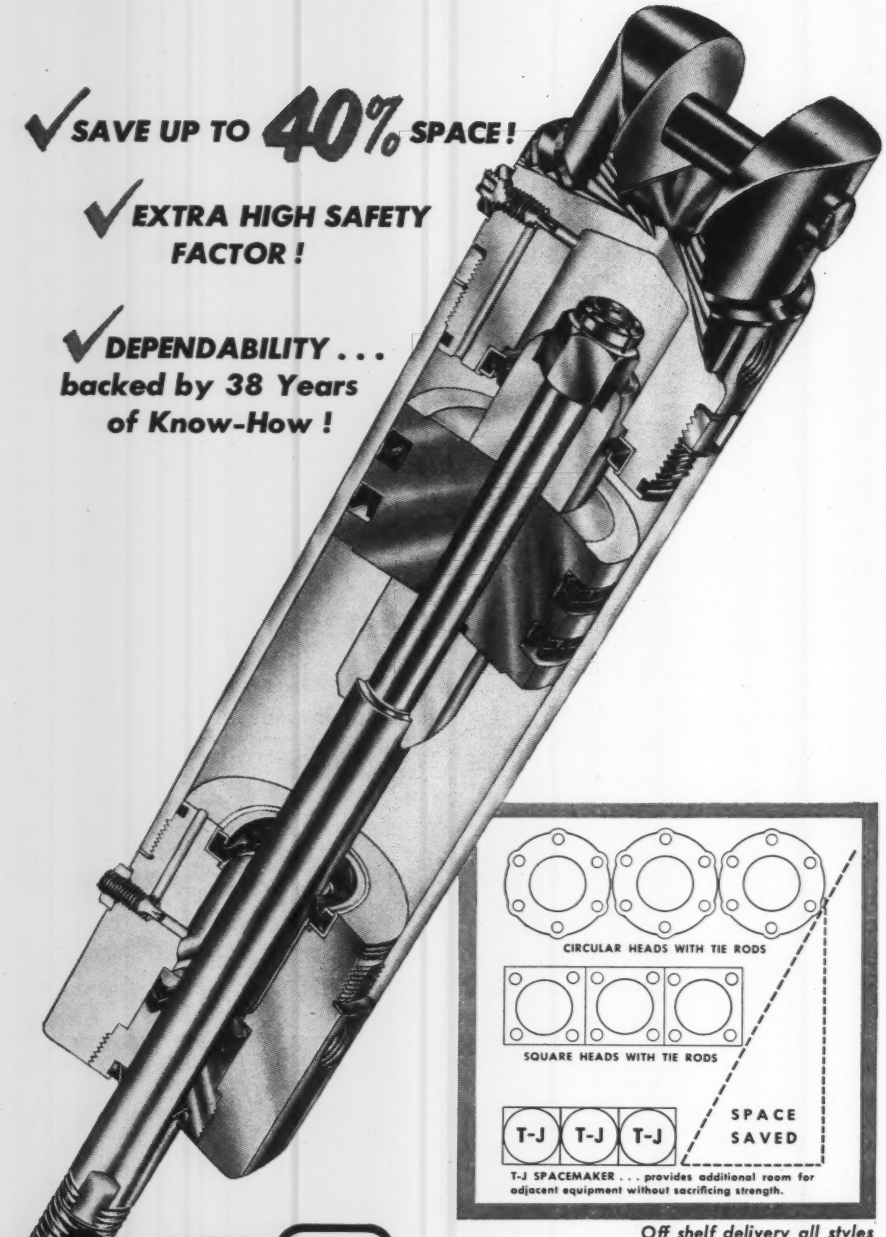

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Design Abstracts

we cannot grasp it. There is a reason for man's search for understanding which extends beyond his immediate needs for food and shelter. This reason is his inherent urge to know. We share the great adventure with one another. Let us together pursue science for the practical benefits it may yield. But let us pursue it also because we would rise above the sordid daily struggle with nature and with ourselves and look out upon the universe and down into its intricacies. Let us pursue science because we respond to the urge which lies deep in all of us to press on toward greater understanding.

From an address of the same title presented before guests of the Board of Directors of Stanford Research Institute in Los Angeles, Calif., January, 1954.

Design Opportunities with Electric Stud Welding

By R. C. Singleton

Industrial Sales Manager
Nelson Stud Welding Div.
Gregory Industries Inc.
Toledo, O.

THE electric-arc stud-welding process is a method of joining metal surfaces using an electric arc as the source of heat. The two surfaces to be joined consist of the stud or fastener which serves as the electrode and the base plate or work piece to which the stud is to be joined. In operation, the stud is placed in a spring-type chuck on the end of the welding gun and a porcelain ferrule or arc shield is placed over the end of the stud. The operator then places the stud gun against the ground work plate in the desired position and closes the trigger switch in the handle. The stud is automatically retracted from the work approximately 1/16-inch and held there for the time interval set in the welding control unit. An electric arc is developed between the stud and plate forming a molten pool of metal which is held in place by the ferrule. The ferrule also shields the arc, prevents oxidation of the weld metal, forms the

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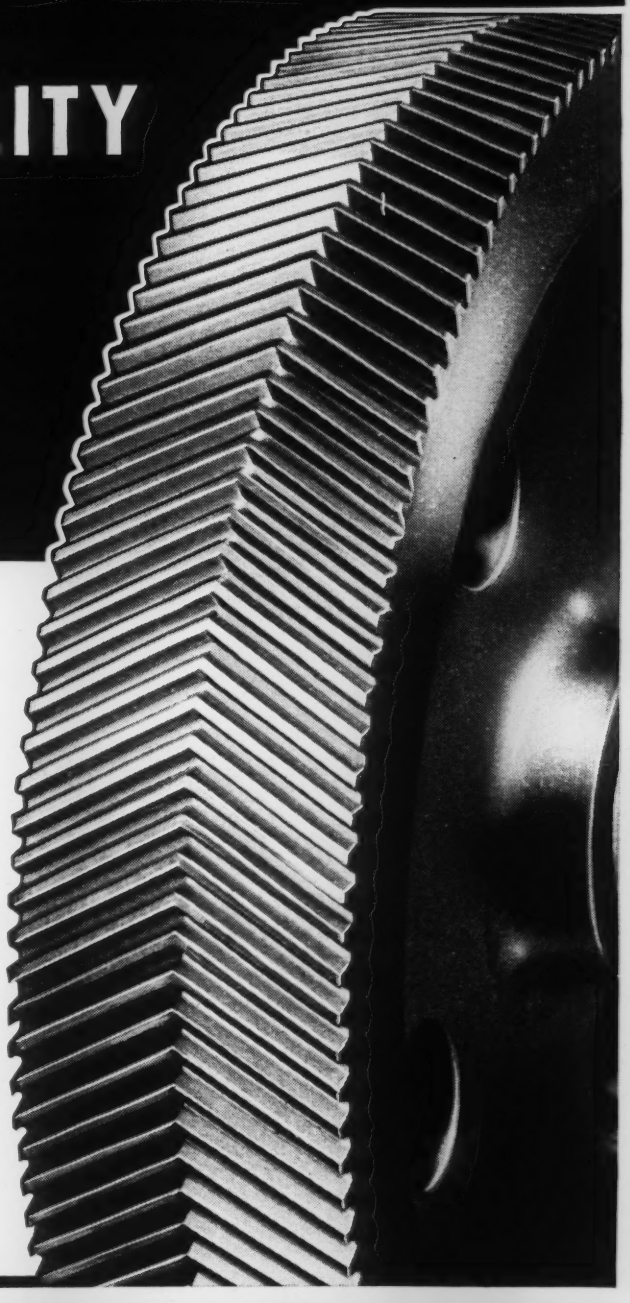


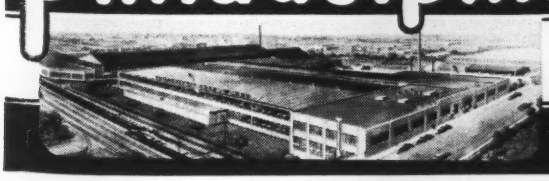
HERRINGBONE GEAR SPEED REDUCERS

Indicative of the well planned design features of Philadelphia Herringbone Reducers is the gear arrangement in the Double and Triple types. In these reduction units, the gears are located symmetrically with respect to the centerline of the housing, rather than the usual offset arrangement. Two standard bearings are provided on each shaft, with each bearing absorbing an equal load. The Philadelphia Gear arrangement allows the use of wide and stable housing, it eliminates the unequal bearing and thrust loads inherent in the off-set herringbone and single reduction reducers.

It is evident then, that Philadelphia Herringbone Reducers with high speed double helical gears spaced equidistant from the housing centerline in the first and intermediate reductions, and with a continuous tooth herringbone gear set on the centerline for final reduction, provide *perfect balance and symmetry.*

For complete construction details write for our catalog H-49.

Philadelphia Gear Works, INC.



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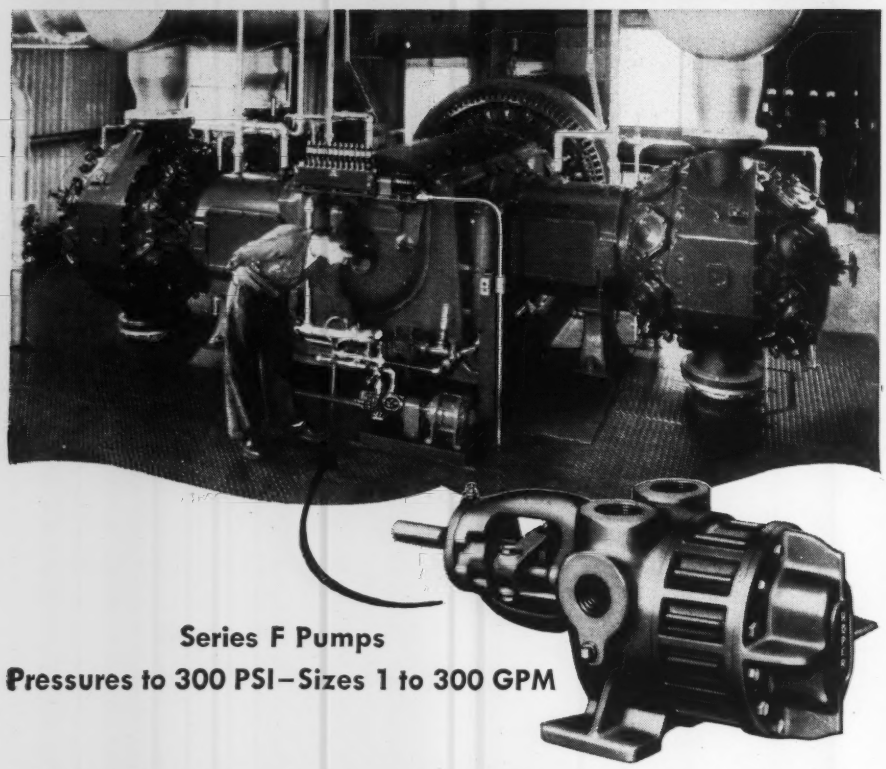

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Giant Cooper-Bessemer Compressor Requires Dependable Bearing Lubrication at Every Start... and a Roper Does the Job!

Producing "miracle" drugs at one of the Chas. Pfizer & Co. plants calls for dry, clean compressed air; the above compressor provides this very necessary ingredient. *Where does a Roper pump fit into the picture?* In this case, a dependable Series F is used as an independent before-and-after pump to supply oil to all bearing surfaces. Also, when the compressor is running at slow speeds, the Roper helps to maintain thorough lubrication by keeping lube oil pressure at a safe level.

This is but one of hundreds of special installations where a standard Roper pump is used. If you have a similar application — or if you require a pump for general purpose pumping, fuel transfer, or for hydraulics — you can count on a Roper to do the job . . . *dependably!*

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Design Abstracts

fillet around the base of the stud, and concentrates the welding heat in the weld area. Upon conclusion of the preset time cycle the welding current is cut off and the stud, by the action of the mainspring in the gun, is instantly plunged into the pool of molten metal to make the weld. The elapsed time of the welding operation will vary from a minimum of 1/20-second for ⅛-inch insulation pins to a maximum of 1½ seconds for the welding of 1¼ inch diameter studs.

Stud Types: A wide variety of sizes, shapes and types of fasteners may be secured by this welding process. The limiting factors of design are:

1. Stud can be welded on one end only.
2. It must be possible to chuck stud.
3. Stud shape must be such that a ferrule can be produced which will fit weld base satisfactorily.
4. Stud must have a cross-sectional area within range of available welding power.

Fasteners being stud welded commercially today will range in size from ⅛-inch to 1 inch diameter. Studs as large as 1½-inch diameter have been welded satisfactorily under laboratory conditions. It appears at this time that the only practical limit to the diameter of studs which can be secured by this method will be determined by the availability of welding current. The 1½-inch stud requires approximately 4500 amperes at 65-70 volts for 2 seconds.

Studs generally are round, square or rectangular in shape. In the rectangular shapes, the smallest and most commonly used stud is ⅛ by ⅜-inch. The largest rectangular stud now being welded commercially is ¼ by 1¼ inches. The ratio between width and thickness of the stud is critical; tests have shown that the welding of rectangular studs is at best difficult when this ratio is more than 5 to 1.

Weldable Metals: It has been found that the welded joint obtained by this process is in every sense a true metal arc weld. As

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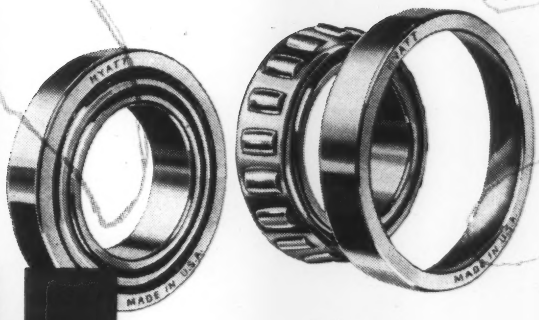

Got a bearing problem? Just reach for Hyatt's new Barrel Bearing Catalog! This is one catalog engineers have been waiting for, because it's essentially *a guide to lower maintenance costs!* Barrel Bearings are not only dual-purpose in design; they're also *self-aligning*. They operate with full efficiency under misalignment conditions which cause excessive wear in ordinary bearings. If *your* job involves bearing specifications, make sure you have Hyatt Catalog No. B-154. It puts a complete line of Barrel Bearings right at your finger tips. Write to Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

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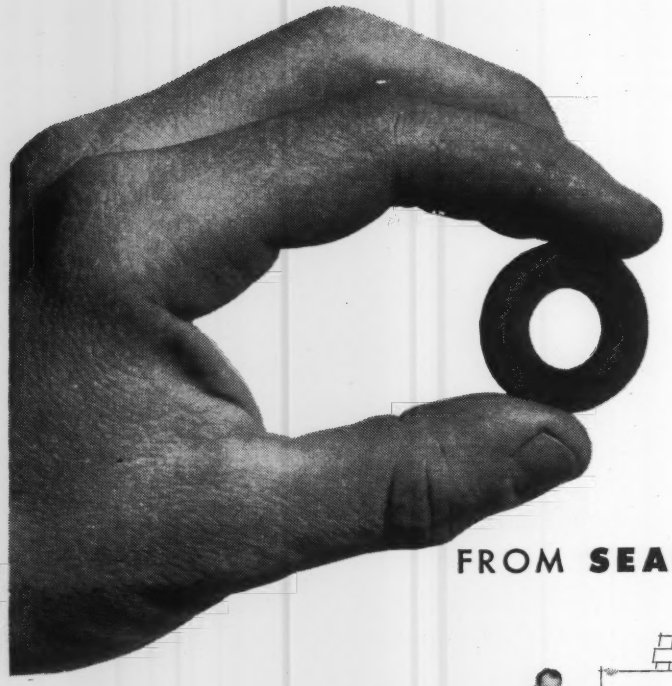

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FELTERS S.A.E. FELTS F-5, F-6 and F-7

are recommended for applications like dust shields, wipers, grease retaining washers, wicks and other uses where a high degree of resiliency is required.

These are 3 of many grades of Felters Felt produced for specific applications.

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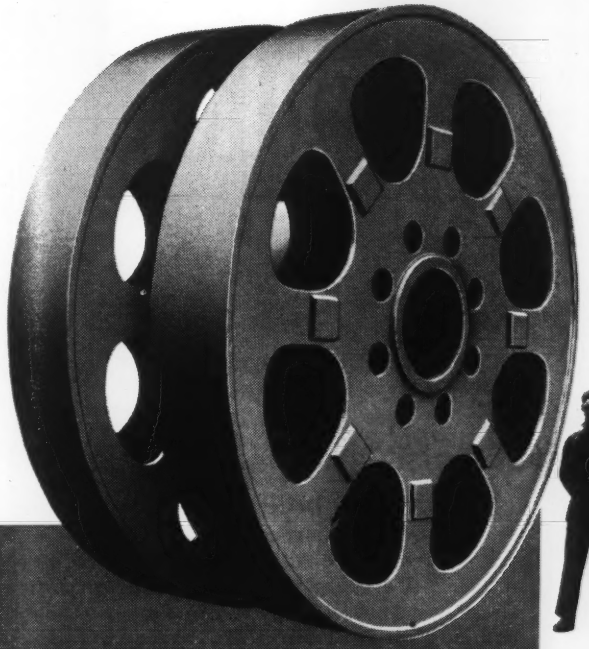
a result of the protective action of the ferrule and the deoxidizing agent in the flux, which is contained within the end of the stud, a clean, dense weld-metal deposit is obtained. The weld strength, with few exceptions, will develop the full strength of the materials being joined. With special materials, modifications in procedure may be necessary in order to obtain the desired properties.

For stud welding the same general rules apply as govern all metal arc welding processes. For example, in the welding of the medium and higher carbon steels it becomes necessary to employ a technique which will eliminate the hardness, and consequent tendency toward brittleness, in heat-affected areas resulting from conventional stud-welding procedures. This hardness develops because of the rapid quenching action of the base plate. Usually in such situations the use of preheat or postheat is suggested to obtain necessary toughness. Generally the safest practice is to use preheat, since this will avoid entirely any possibility of underweld cracking in the heat-affected area. Preheat is always recommended with the straight carbon steels having a carbon content over 0.40 per cent where standard welding procedures are used. In the case of the alloy or medium carbon steels in the 0.30 to 0.40 per cent range, it is often possible to resort entirely to the use of postheat procedures. The determining factor here is whether or not underweld cracking will result before the welded assembly can be heat treatd.

Stud Welding Steels

With minor variations in the practice indicated, it is possible to weld practically any of the carbon steels or any of the commonly available alloy steels. The exact procedure used will depend upon the particular alloy and the heat treat to which the part is subjected in the production cycle. It is often possible to work the stud welding process into the production cycle in such a way as to obtain the necessary heat treatment without additional operations



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We welcome the opportunity of furnishing either the complete assembly or any weldment part that is beyond your capacity.

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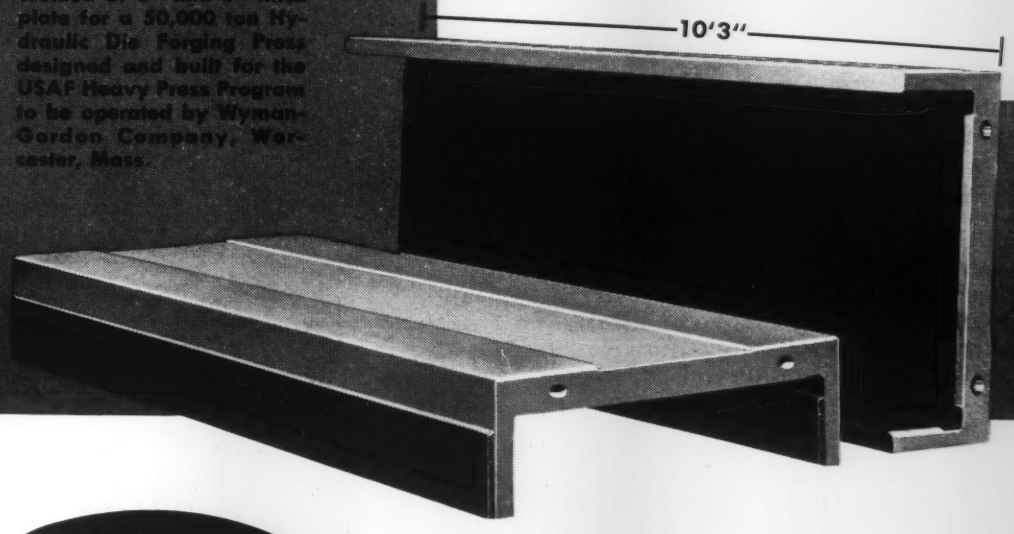

Struthers Wells

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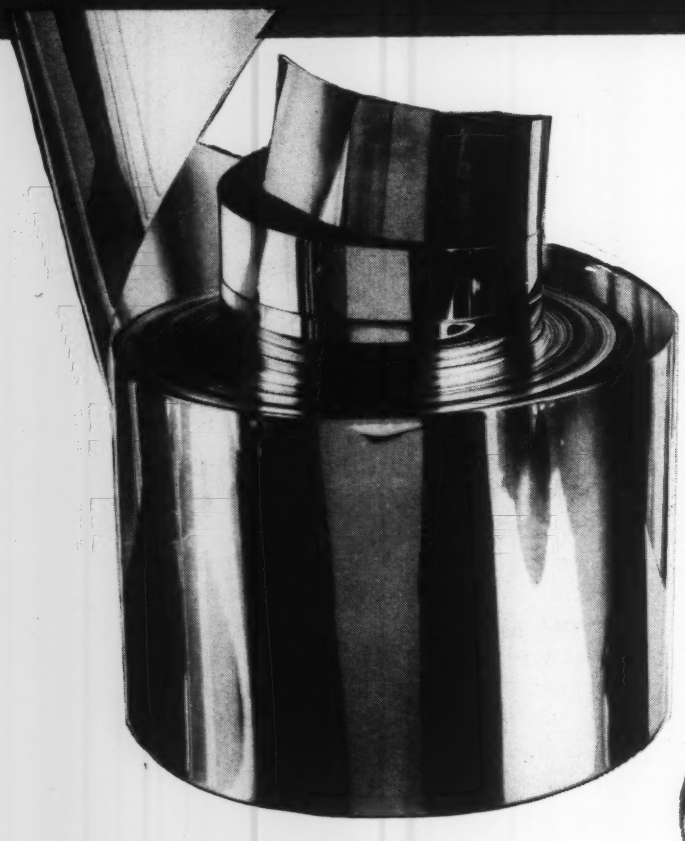
Plants at Titusville, Pa. and Warren, Pa.

NICKELOID METALS STARTING POINT FOR PRODUCT DESIGN



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In addition to the more common steels, it is standard practice to weld stainless steel studs of the austenitic chrome-nickel class. Included would be most of the 300 series; i.e., 302, 304, 309, 316, 320, etc. Because of a tendency toward brittleness in the weld section, the 400 type straight chrome stainless steels are usable under special conditions only.

For special applications, procedures have been worked out for the welding of most of the common copper-nickel alloys and the high chrome-nickel alloys such as Monel and Inconel. In the case of Inconel, it is possible to develop the full strength of the material when welded to either mild steel or Inconel, providing proper heat treating procedures can be included in the fabrication procedure. Monel has proved to be a difficult material to handle with the stud welding process. In most cases it is possible to develop more than adequate strength in the weld section but, because of a tendency toward brittleness under some circumstances, it is suggested that a joint efficiency factor of 70 per cent be used.

Brasses and bronzes of most of the familiar types have been satisfactorily welded with the stud welding process, using more or less straightforward procedures. However, results will vary from alloy to alloy. Also, to obtain consistent results both stud material and base plate must be completely free of lead.

Several procedures have been worked out for the welding of certain grades or types of aluminum alloys. Nearly all methods use the inert gases, helium or argon or a mixture of both, to provide a protective atmosphere during the actual welding operation. For the most part, the stud-weldable alloys are those very rich in aluminum and with a minimum amount of alloying agent. Little success has been reported to date in the welding of the heat-treatable grades of aluminum.

Weld Properties: All types of tests have been used to determine

(*Continued on Page* 292)

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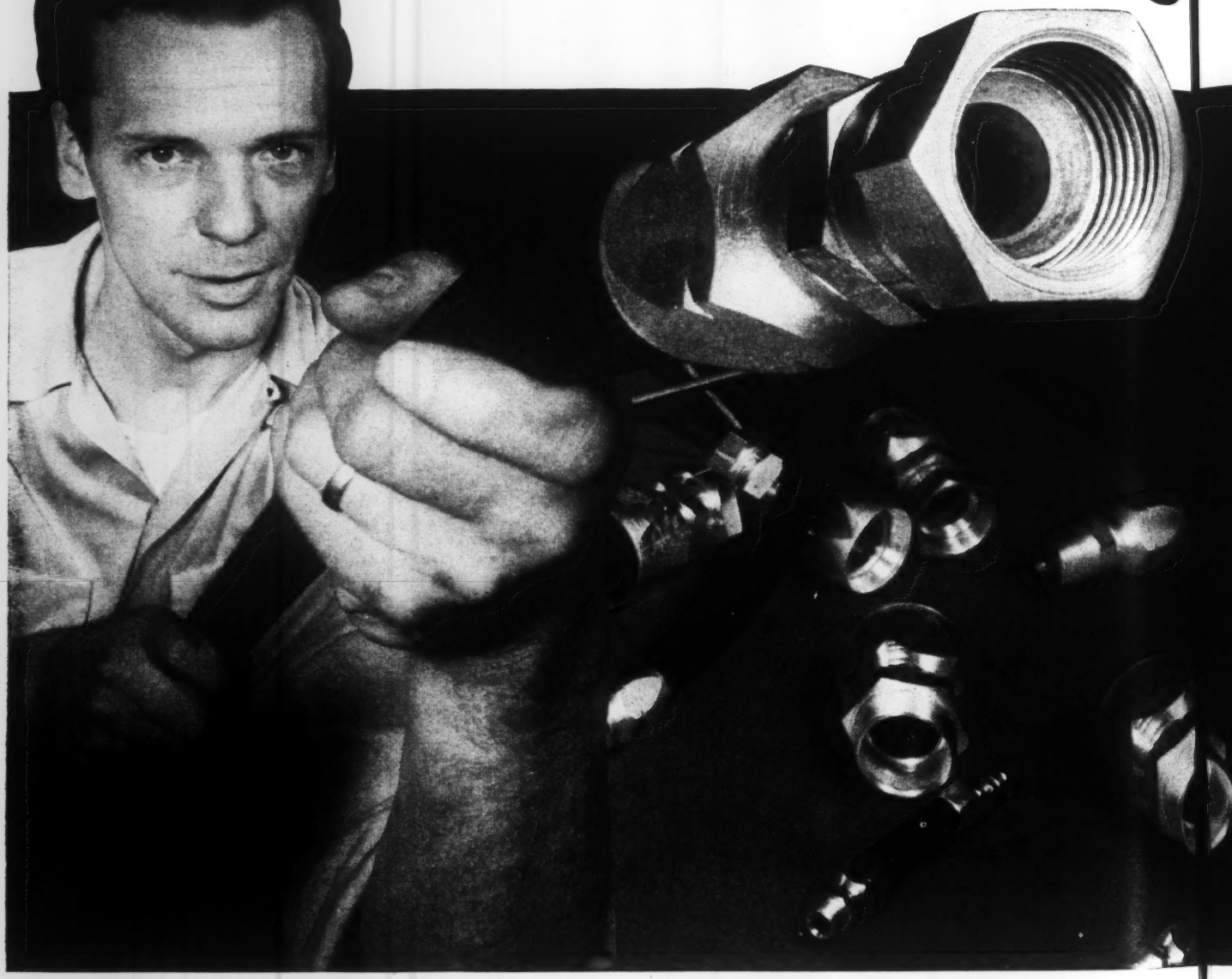
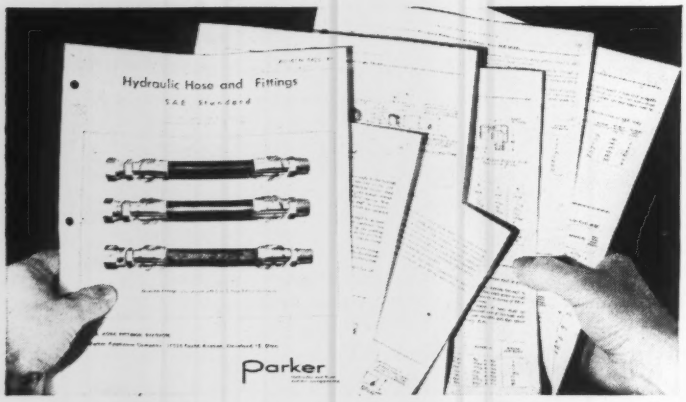
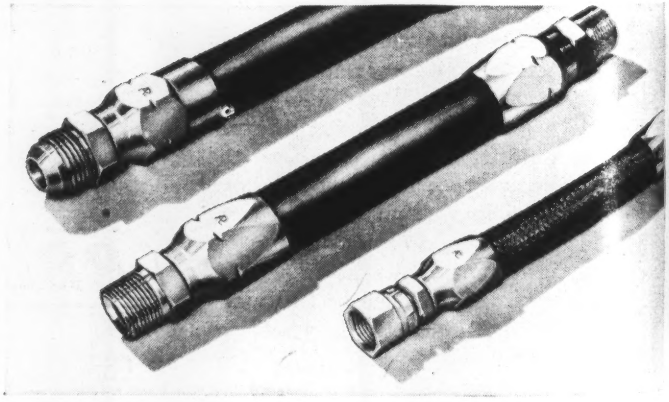


Here is *Hoze-lok* showing the type for medium-pressure, rubber-covered, single-wire braid hose. *Hoze-lok* has a unique socket recess to provide greater gripping. It is *re-usable* . . . easy to assemble. End of the socket is streamlined with no abrupt corners to cut assembler's hands. See how *Hoze-lok* fittings have a neat appearance in harmony with modern-design machinery.



S.A.E. Standards for hydraulic hose and fittings are fully met by new Parker *Hoze-lok* fittings. See pages 725 to 730 of your S.A.E. Handbook. Or, simply mail the coupon for the reprint shown above.



3 styles for cotton-covered or rubber-covered, single-wire braid hose in medium-pressure service; for rubber-covered, double-wire braid hose in high-pressure service.

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Look at these unique features of Parker's new *Hoze-lok* fittings and hose assemblies for medium and high-pressure hydraulic service:

Hoze-lok fittings offer longer trouble-free service. They have an unusually large gripping area because of their deep socket recesses. They won't pull out.

These new fittings conform to both S.A.E. Hydraulic Hose and Fitting Standards and the hose fitting specifications of J. I. C. Hydraulic Standards.

Parker *Hoze-lok* fittings make up easier . . . save time and temper of assemblers. Socket thread is larger than braid diameter, making it easier to insert the hose end into the socket. Contour of the socket provides greater wrench clearance at hex of nipple. Also, this easier make-up simplifies fluid handling for mock-ups or for testing purposes . . . saving expensive engineering time.

Greater re-usability of *Hoze-lok* fittings cuts costs in these ways: Parts of old hose lines can be salvaged, fittings detached and removed. You don't have to carry such a large inventory. A small stock of bulk hose and *Hoze-lok* fittings takes care of most requirements.

Hoze-lok fittings are now available for both medium and high-pressure hose. Also, these new fittings are augmented by a wide range of *Triple-lok* (tube fitting) connecting adapters. Mail the coupon for Catalog No. 4400 and ask for name of nearest *Hoze-lok* distributor.

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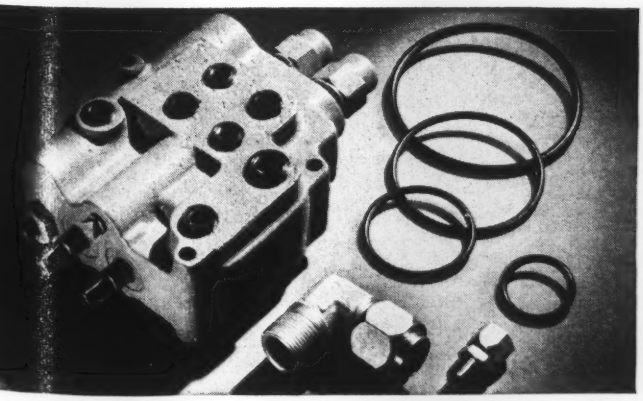

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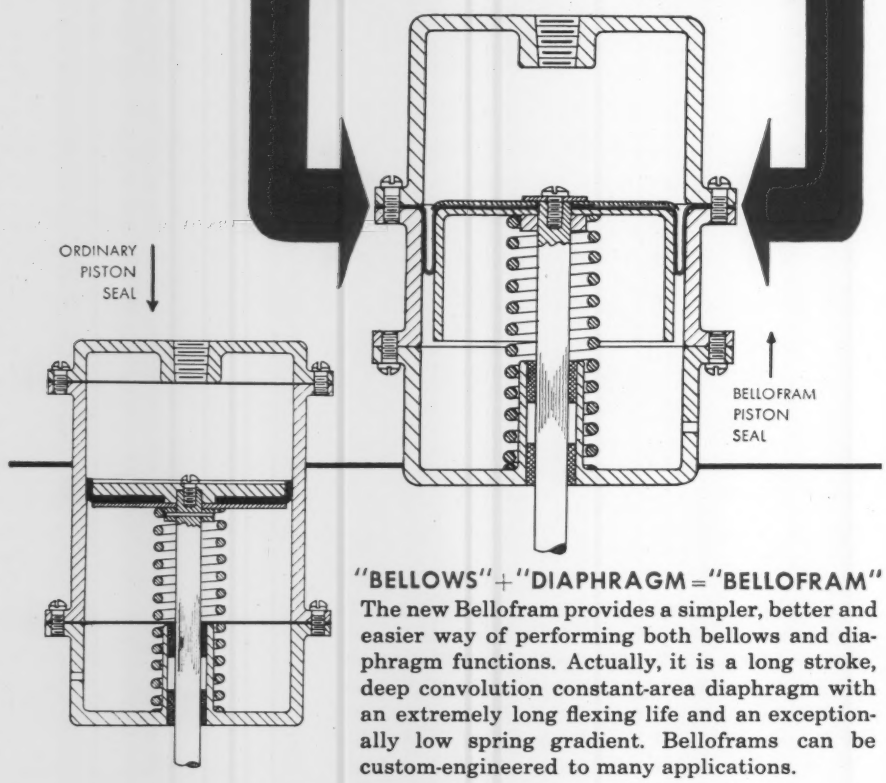

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144 MOODY ST., WALTHAM, MASS.

Design Abstracts

(*Continued from Page* 289)

the physical properties of end-welded studs. These tests have abundantly proved that the welds obtained by this process are sound and that the determining strength factor is the minimum fastener cross-sectional area. For this reason it is recommended that handbook values for mild steel bolts be used in making design calculations. These values are generally on the conservative side since the steel most commonly used in making studs will have a higher tensile value (75,000 to 85,000 psi).

In the process of making a weld by this method, the plunging of the stud to complete the weld causes a fillet to form around the base of the stud. The dimensions of the fillet are closely controlled by the design of the ferrule. Nevertheless, the fillet diameter will in nearly all cases be greater than the diameter of the fastener. This may require special consideration in the design of mating parts. For dependable results the weld base area must be equal to or greater than the cross-sectional area (based upon minor diameter) of the threaded portion of the stud. Usually this will indicate a maximum of 1/16-inch reduction on the diameter of the weld base.

From a paper entitled "Ferrous and Nonferrous Stud Welding" presented at the Twenty-Second Annual Meeting of the American Society of Tool Engineers in Philadelphia, Pa., April, 1954.

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By G. T. Fraser

Sales Manager
Rem-Cru Titanium Inc.
Midland, Pa.

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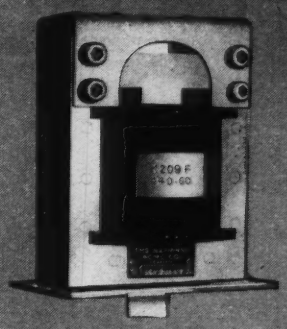

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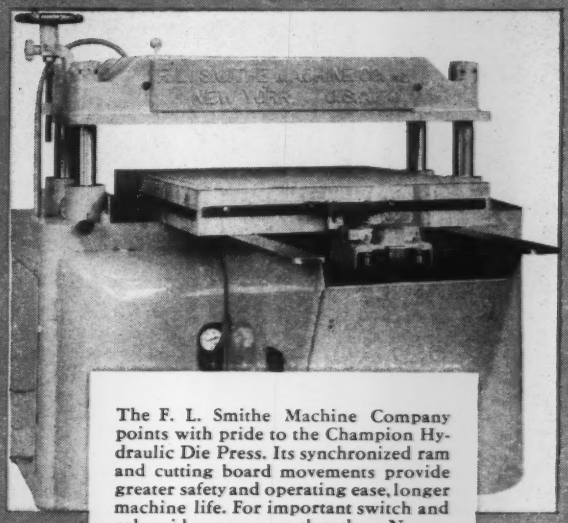
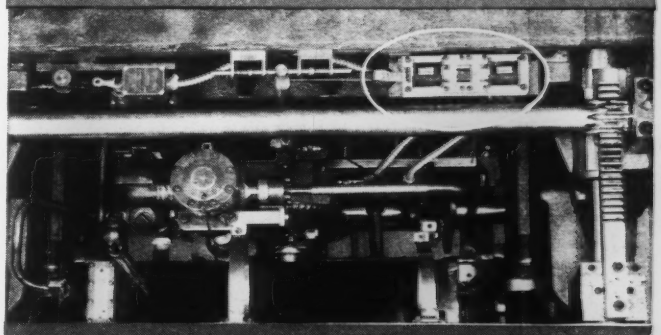
OPERATE SWITCHES	HOLD CHUCKS
CONTROL MACHINES	OPERATE VALVES
MOVE LEVERS	VIBRATE CUTTING KNIVES
PRINT SYMBOLS	OPEN AND CLOSE DOORS
OPERATE SAFETY DEVICES	OPEN AND CLOSE HOPPERS
EJECT WORK IN PROCESS	SORT INSPECTED PARTS

Namco "Stellite"-weld Solenoids are built in sizes with ratings from 2½ to 25 pounds, push or pull, at maximum 1″ stroke. We'll be glad to recommend the size and style best suited to your job—ask our engineers to talk it over with yours.

Engineering BULLETIN EM-52 gives details on standard Namco Solenoids.



The F. L. Smithe Machine Company points with pride to the Champion Hydraulic Die Press. Its synchronized ram and cutting board movements provide greater safety and operating ease, longer machine life. For important switch and solenoid components, they chose Namco Snap-Locks and "Stellite"- weld solenoids.



Packaging machines, shearing devices, valves, envelope machines and many others perform better longer with Namco Solenoids. "Stellite"-weld and hard chrome plate bonding on plunger, sturdy construction and highest quality coils make Namco Solenoids long lived, rugged, DEPENDABLE.

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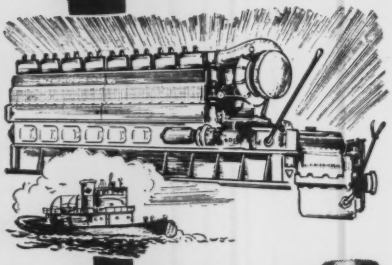
ERIE the correct fastener for the job!



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Representatives in Principal Cities.

Design Abstracts

lighter than steel, has about the same, or greater, tensile strength as structural steel and has corrosion resistance comparable to or better than 18-8 stainless steel in most media. It also possesses good mechanical properties. These characteristics have made the metal desirable among the aircraft manufacturers and Army Ordnance. Because of costs, nondefense industries have not been able to utilize titanium extensively, but this condition should correct itself in the future.

A study of physical characteristics places titanium in a category of its own and, therefore, it should not be compared closely to other metals, since the comparison will be valid only to a limited degree and might lead to erroneous generalizations.

Carbon solubility in titanium is about 0.20 per cent. Alloys having between zero and 0.20 per cent carbon will have similar machining characteristics, but alloys above 0.20 per cent carbon reduce tool life markedly.

Seizing tendency and rate of work hardening of titanium necessitates generous depth of cuts to prevent riding of tools on the work with resulting excessive tool wear. The low thermal conductivity combined with the galling tendency gives rise to the use of slow speeds and heavy cuts. Scaling occurs by formation of titanium oxide and nitride at temperatures above 1200 F. These are among the hardest materials known and should be removed prior to machining by either chemical or mechanical means.

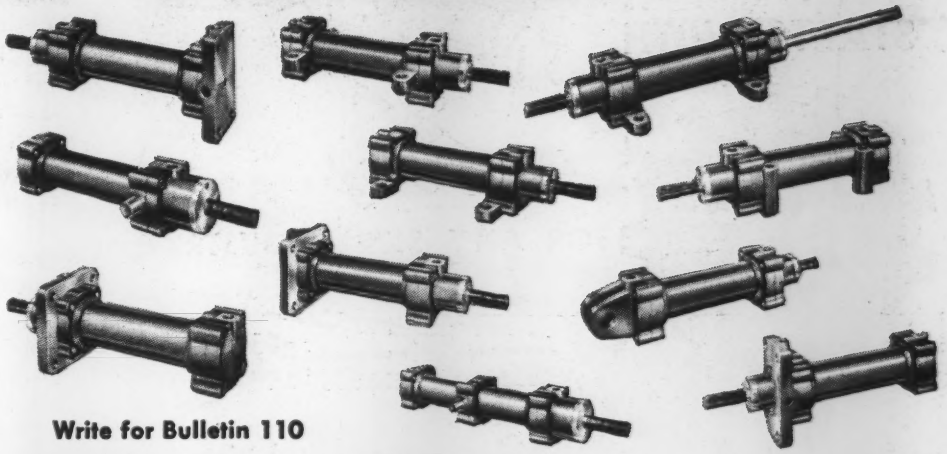
Usually the machinability of steel can be gaged by its hardness, as there is a correlation between hardness and physical property strength, but with titanium there is no such correlation. The alloys and the commercially pure grades are stringy and tough to machine.

Turning: Sturdy, rugged machines and tools are important to eliminate tool chatter and be capable of maintaining uniform, positive cutting feeds and speeds. High speed steel cutting tools are more satisfactory than carbides for machining titanium. Titanium tends

FOR YOUR

SERIES "N" HYDRAULIC CYLINDERS

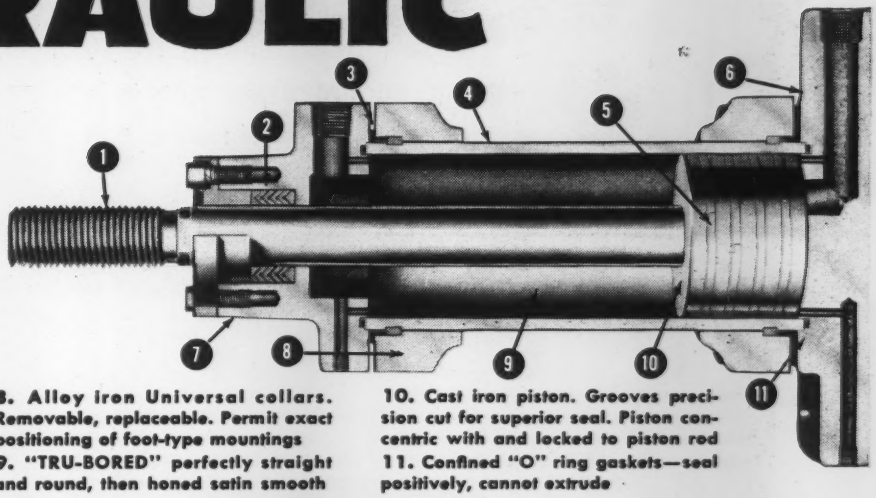
- Long recognized as the finest hydraulic cylinder made.
- No tie rods; ideal for long-stroke applications
- 12 bore sizes, 1" to 8"
- 11 mounting styles; many combination mountings available



Write for Bulletin 110

HYDRAULIC

ADVANTAGES



1. Ground steel piston rod. Concentric with and locked to piston
2. Pre-adjusted chevron packings in non-adjustable gland. This eliminates over-tightening, binding, etc.
3. Alloy steel bolts—heat-treated for strength
4. Seamless steel cylinder. Extra strength. Piloted to end caps to assure concentric assembly
5. Positive seal piston rings. Lapped both sides for minimum oil slip
6. Alloy iron Universal end caps. Rugged. Port completely rotatable—air vents four sides
7. Cushioned caps when specified. Eliminate shock at end of stroke
8. Alloy iron Universal collars. Removable, replaceable. Permit exact positioning of foot-type mountings
9. "TRU-BORED" perfectly straight and round, then honed satin smooth
10. Cast iron piston. Grooves precision cut for superior seal. Piston concentric with and locked to piston rod
11. Confined "O" ring gaskets—seal positively, cannot extrude

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- Specially designed for each application
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Automation

STARTS WITH

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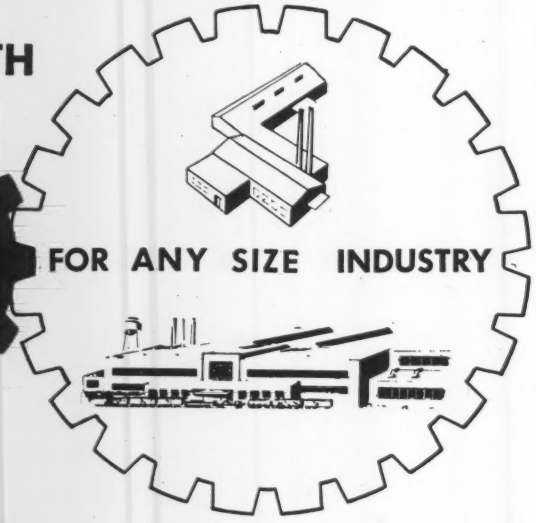
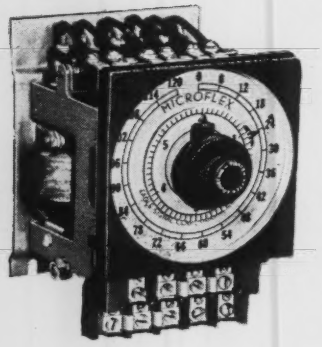
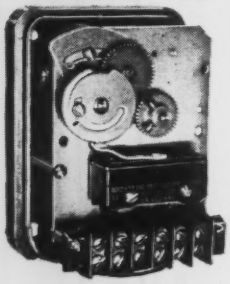


FOR ANY SIZE INDUSTRY



MICROFLEX
Bulletin 110



MONOPULSE
Bulletin 322

Eagle industrial timers are playing an important role in the new era of automation.

Eagle manufactures the most complete line of timers available, from the "Microflex", the king of timers, in accuracy, dependability and versatility, to the simpler "Monopulse".

Let experienced engineers suggest the right timer to increase profit in your individual process. Send your problem to Eagle today.

Write for **FREE BOOKLET**
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Industrial Timers by **EAGLE**

EAGLE SIGNAL
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MOLINE, ILL.

Design Abstracts

to build up more readily on a carbide tool which leads to chipping of the cutting edge and shortened tool life.

Drilling: In drilling, a slow speed with a steady, positive feed is essential to prevent work hardening in the bottom of the hole. A heavy duty drill as short as possible is recommended to prevent springing and breakage. Air motors or electric drills can be used provided they are equipped with speed reducers to conform with the slow, steady drilling speed required.

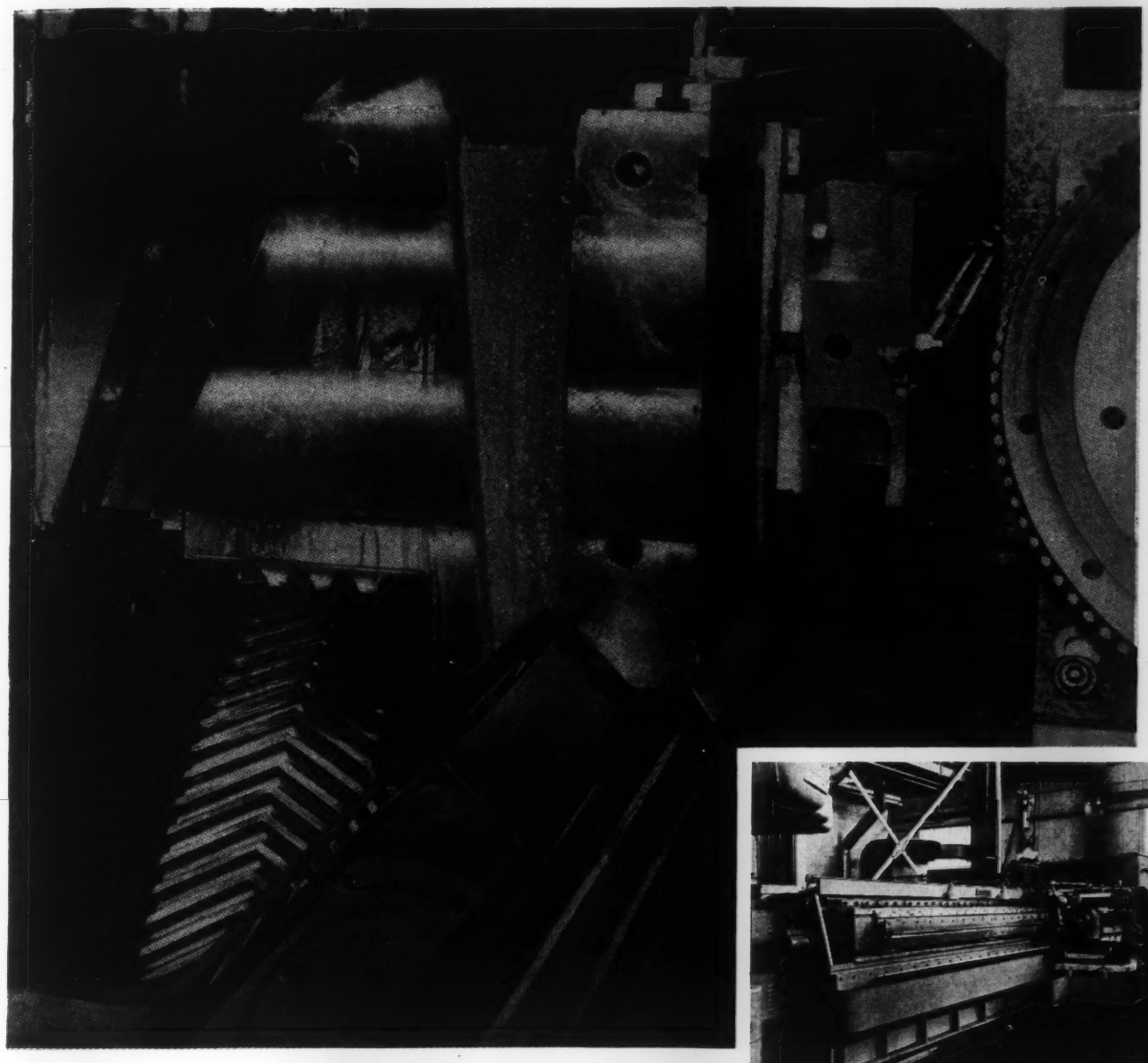
Variable feed will cause smearing and result in rapid dulling of the drill. The reaction will be similar to a condition of work hardening in stainless steel. For exceptionally deep hole drilling, a gun drill should be used for best performance.

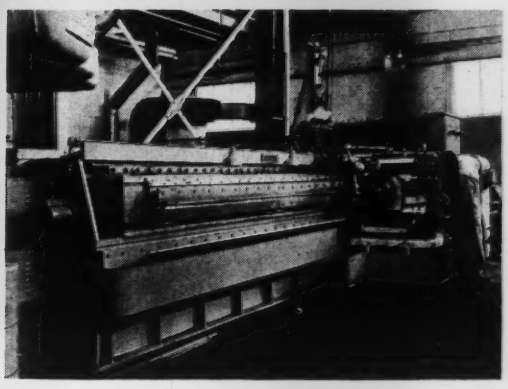
Tapping: There is still much to be desired in the way of a suitable tap for tapping titanium. Tapping has been most difficult because of the interference between the resultant chip and the cutting edges of the tap.

Milling: High speed steel has been found best for use in milling titanium. "Climb milling" is recommended, as this permits the cutter to leave the work with a fine chip and decreases the tendency of the cutter to chip because of a heavy build up at the cutting edge. Both cast alloy and carbide cutters have been used satisfactorily at 50 to 75 sfm and 65 to 120 sfm respectively.

Broaching: Like tapping, broaching has been a troublesome operation. The design of the broach for broaching titanium is important. Sharp corners in titanium cannot be maintained, therefore, should not be incorporated in design. Satisfactory operation will result if slow speeds are employed and the set-up is rigid.

Sawing: Band sawing is practical for sections under ½-inch thick. Frictional sawing is now practical since satisfactory cutoff wheels have been developed for use in cut-





300 FPM Lapointe broaching machine has Farrel® herringbone rack drive

The Lapointe horizontal and vertical broaching machines, with electro-mechanical drive, are outstanding developments in broaching. The horizontal machine shown here is capable of broaching many jobs heretofore impossible, at speeds up to 300 FPM and more.

Farrel continuous tooth herringbone rack and gears drive the main slide. The quiet, vibration-free performance of this drive, which results from extreme accuracy of tooth spacing, contour and helix angle, is an important factor in attaining broaching smoothness at these high speeds.

Farrel herringbone gears are made of the finest grade materials, in any size from ¼ inch to 20 feet in diameter. Also available are straight tooth and single helical gears in sizes up to 20 feet diameter, and internal gears with either spur or helical teeth up to 16 feet diameter.

A Farrel engineer is available for consultation at your convenience, without obligation.

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FB-905

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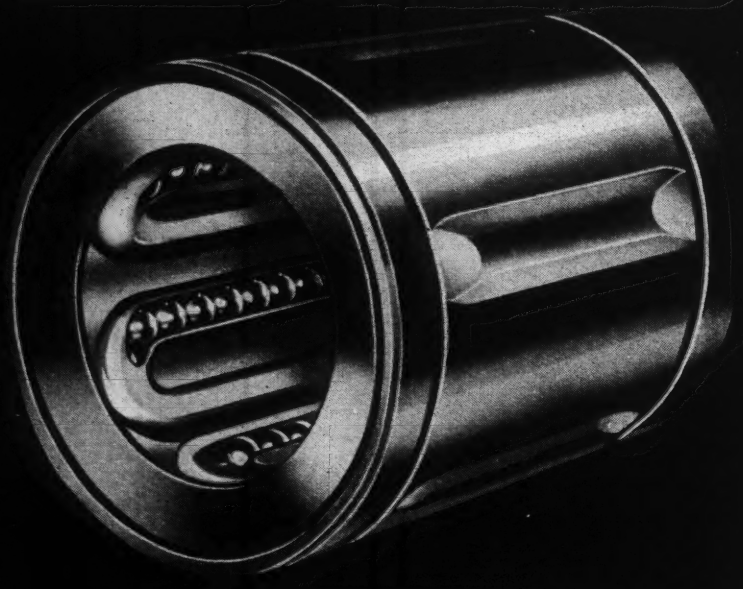

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Sliding linear motions are nearly always troublesome. Thousands of progressive engineers have solved this problem by application of the Precision Series A or Low-Cost Series B BALL BUSHINGS.

Alert designers can now make tremendous improvements in their products by using BALL BUSHINGS on guide rods, reciprocating shafts, push-pull actions, or for support of any mechanism that is moved or shifted in a straight line.

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Now manufactured for ¼", ½", ¾", 1", 1½", 2" and 2½" shaft diameters.

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Also manufacturers of NYLINED Bearings — DuPont NYLON within a metal sleeve—for rotation and reciprocation.

Design Abstracts

ting titanium.

Grinding: The operation of grinding was most unsatisfactory, but has been improved considerably during the past two years. Today external and internal grinding of a finish and semifinish nature is fairly good with improvements continuing to be made. Snag grinding and intricate form grinding have yet to be measurably improved. The ratio between wheel wear versus metal removal was 1 to 1, but today this ratio is about 1 to 6 with some reports on internal grinding up to 1 to 50. An aluminum oxide type of wheel is generally recommended in preference to a green silicon carbide wheel.

Forging: The machining of titanium has been done primarily on titanium forgings. The metal lends itself well to all types of forging. Titanium requires more draft and fuller fillets than steel. Forging temperatures are somewhat lower than those for steel: 1650 to 1800 F for heavy reductions of large sections and closed-die or contour forgings and 1450 to 1550 F for lighter reductions. Titanium should not be allowed to soak at the forging temperature but should be worked upon reaching desired temperature.

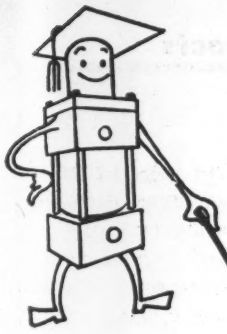
Mechanical properties of titanium forgings are comparable to those of the wrought material. An efficient method for producing large forged disks is on a press or by roll-forging. Control of the final reduction will permit the use of cold working in the lower temperature range (1300 to 1350 F) for obtaining higher physical properties in the finished forging.

Sheet Fabrication: Forming characteristics of annealed commercially pure titanium sheet can be compared with ¼-hard stainless while the alloy sheet compares with ½-hard stainless steel. Commercially pure titanium sheet cold forms reasonably well, although its crystal structure is similar to that of magnesium. Greater pressures are required than in low carbon steels, slower press speeds are de-

Miller

FLUID PRESSURE BOOSTERS

In "Custom-Built" and "Stock" Models

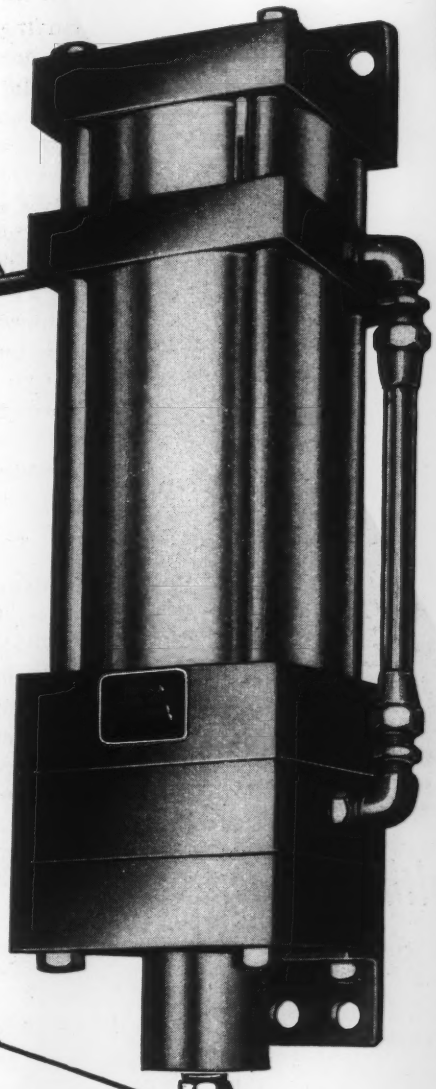


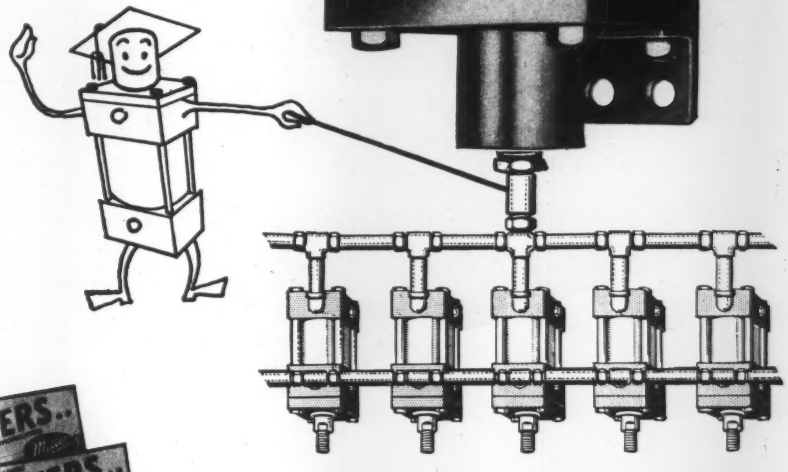
BOOST 80 PSI AIR

Input Range: 40 to 3000 psi Air or Fluid

TO 2000 PSI HYDRAULIC PRESSURE

Output Range: 200 to 10,000 psi Fluid

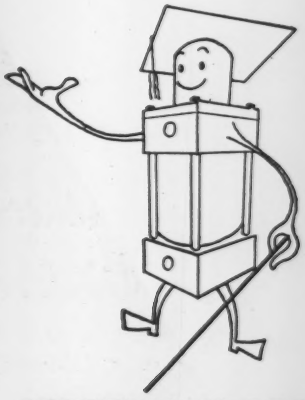




Get immediate delivery on the popular 5" bore Miller B4 (Air-Miser) Dual Pressure Booster, Model 53, with a 1" dia. hydraulic ram and "stocked" in your choice of either 6" or 12" stroke. Booster ratio is 25 to 1 (80 psi air input provides 2000 psi hydraulic output for driving one or more work cylinders simultaneously).

Separate booster air-oil tanks of 5" bore, in both 6" and 10" heights as desired, are also available for immediate delivery together with foot mounting attachments for speedy conversion of Model 53 to Model 71.

These "Stock" Boosters are identical in quality to Miller "Custom-Built" boosters which are available on normal scheduled delivery in a wide selection of models, ratios and output capacities as described and illustrated in Bulletin B-200. Write for bulletin and prices.



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- **PUNCHING**
- **SHEARING**
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and similar applications

FULL DETAILS IN MILLER BULLETIN B-200 SENT FREE ON REQUEST
Other Miller products include: Air cylinders, 1½" to 20" Bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

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● Every Anker-Holth Cylinder... large and small... is tested at 150% of working pressure with the latest completely-filtered testing equipment. Anker-Holth testing facilities include portable units such as the one shown... also stationary equipment for pressures up to 10,000 psi.

This is one of many safeguards in manufacturing to assure you top performance and dependability in Anker-Holth Cylinders. There's a type and size of cylinder to match *your* need. Anker-Holth engineering know-how is available to help solve your power motion problems. Call or write ANKER-HOLTH DIVISION of The Wellman Engineering Co., Dept. A-9, 2723 Conner St., Port Huron, Michigan.

FREE: *Bulletin on complete line of ANKER-HOLTH products.*

Anker-Holth
ENGINEERED CYLINDER POWER
WELLMAN

Division of THE WELLMAN ENGINEERING COMPANY

Design Abstracts

sirable, and when multiple stage operations are necessary, interstage annealing is required (1075 F for 15 minutes). When difficulty is encountered in cold forming, the material will often be formable at 800 F. The alloy sheet is usually hot formed at 800 to 1000 F. Temperatures in excess of 1000 F should be avoided since an oxide forms which is not readily removed by pickling.

Spinning: Commercially pure titanium can be readily spun providing operation is done at 800 F. The metal will not spin cold.

Rubber-Pad Forming: The forming of titanium requires high uniform pressures, 2500-5000 psi, and slow speeds. With the exception of simple parts made from light gage material up to 0.040-inch, best results will be had by forming at 800 to 1000 F. The average flange spring back for commercially pure titanium sheet is 5 degrees when hot formed and 8 degrees when cold formed; for the alloy sheet, 9 and 12 degrees, respectively. Compression wrinkles can be worked out by hand at 400 to 500 F.

Stretching: Both the commercially pure and alloy sheet are suited for cold stretching. The sheet should be initially stressed to approximately its yield strength and then slowly formed. When formed, the piece should be held in contact with the die for a short "setting period" of about 30 seconds before releasing pressure. At no time should the sheet be jerked. The clamping jaws should be designed so that they grip the section being stretched in a uniform manner.

Drawing: Commercially pure titanium sheet can be deep drawn at 800 F. The major difficulty in deep drawing and forming at this time is lack of a suitable lubricant. Draws 2 inches wide by 4 inches long by 4 inches deep with 0.050-inch thickness material have been successfully made in one operation without wrinkling.

From a paper entitled "What

Improved Dual Sealing... with Single Seal Economy

New 2-lip design with more effective sealing surfaces makes this the modern replacement specification for compound element seals . . . giving increased sealing efficiency at minimum cost . . . and more compact seal housing.

Made in two types, both with oil-, age-, and heat-resisting Victoprene synthetic rubber elements. Exclusive Victor mechanical and chemical bonding of element and metal case assures permanent single-unit structure.

TYPE K4 FEATURES

1. Dual sealing members for maximum retention of lubricant and exclusion of extraneous matter.
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3. Unitary construction for minimum width requirements. Available in minimum width of ¼-inch.
4. Available with or without Victoprene rubber on O.D.
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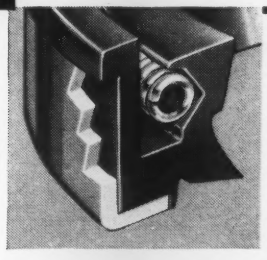
6. External or secondary sealing lip molded with initial light interference permits satisfactory installation. Upon installation, the primary sealing lip displaces to increase sealing efficiency of secondary member through flex action.

One-piece Victoprene Type K4 and K6 Oil Seals

Type K6 . . . without Victoprene on O.D.

For installations not requiring Victoprene on outer periphery and outside face of seal. Otherwise, design of 2-lip sealing element and unitary molded construction are identical with that of Type K4.



Complete information on K4 and K6 seals supplied through your Victor Field Engineer, or on request to the factory. Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill.

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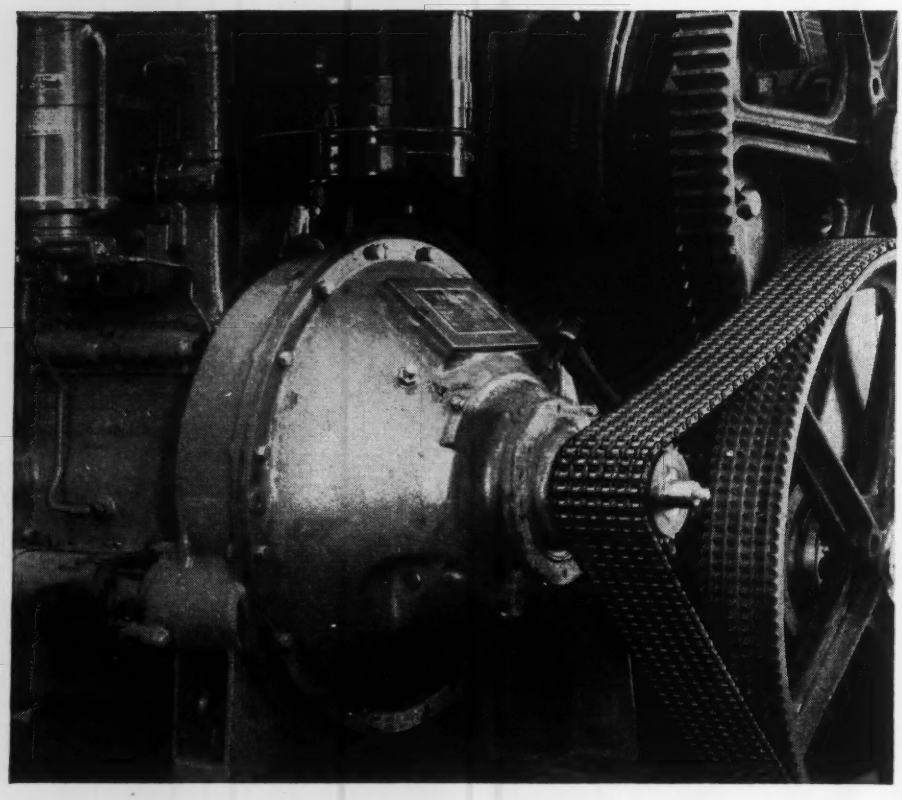
Victoprene Oil Seals

SEALING PRODUCTS EXCLUSIVELY



Why Leading Engine Manufacturers STANDARDIZE ON TWIN DISC Power Take-Offs

Next time you're watching powered equipment driving through a friction power take-off, check the name plate on the drive back of the engine. In all probability, you'll see a Twin Disc Power Take-Off, putting *more horsepower to work.* With their simple, *rugged* design—single-point adjustment—and slippage capacity far in *excess* of horsepower rating, *Twin Disc Power Take-Offs are selected as standard equipment by most of the nation's leading industrial engine manufacturers.*

That's why you'll find Twin Disc Power Take-Offs on such leading industrial engines as Ajax - Buda - Caterpillar - Climax - Continental - Cummins - Hercules - International - LeRoi - Minneapolis-Moline - Murphy - Superior - Waukesha - White - Wisconsin . . . for these manufacturers know they can depend on Twin Disc performance . . . and they know, too, that wherever their engines may be ultimately working, Twin Disc Service will only be a matter of hours . . . backed by 60 Parts Stations and 8 Factory Branches or Sales Eng. Offices.

Twin Disc Power Take-Offs are available with clutches ranging from 6.5" to 24" single-plate; from 11.5" to 24" double-plate. Housing sizes No. 6 SAE to No. 00 SAE. Capacities up to 600 hp. Write for Bulletin No. 129-C.

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Design Abstracts

Is Known Today about Machining Titanium" presented at the Twenty-Second Annual Meeting of the American Society of Tool Engineers in Philadelphia, Pa., April, 1954.

Standardizing Electronic Controls

By Ben Cooper

Specialty Control Engineering
General Electric Co.
Schenectady, N. Y.

THE need for standardization of performance specifications for electronic controls has today taken on a dual importance. Users of electronic controls need performance specifications to select the correct unit to perform a required function. Manufacturers need performance specifications to determine what must be built into the control in order to satisfy the requirements of the user.

Performance specifications are statements of the operational characteristics, limits and ratings of a device or system. They should include: (1) Functions for which the device or system is designed, (2) rating of the device or system expressed in terms of voltage, current, speed, regulation or whatever the function might be, (3) limits or conditions under which these functions and ratings can be performed successfully and tolerance of performance, and (4) additional application data which will aid in the use or application of the device or system.

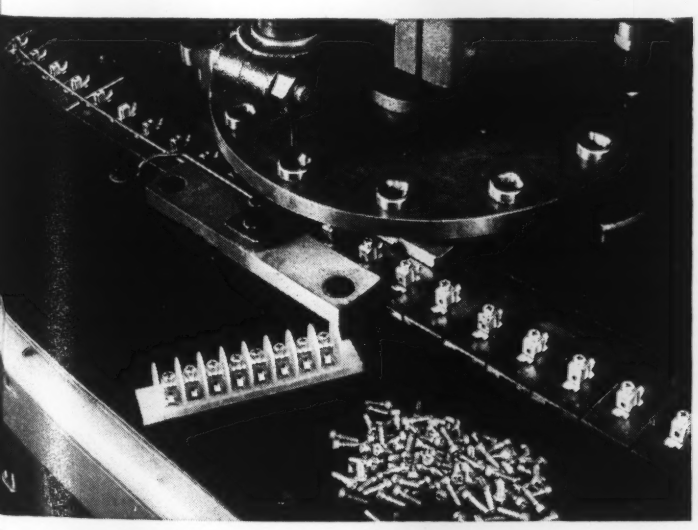
Industrial controls fall into two principal groups: Open-cycle control devices or systems, such as electronic timers, photoelectric relays, or resistance welding controls and closed-loop systems such as position regulators and voltage regulators. Although control complexity may be greater in the case of closed-loop control systems, the need for more exact specifications is equally important in each area and in each area there are many examples of confusion, poor terminology and misunderstanding.

Electronic Timers: In supplying

Users praise Phillips Cross-Recessed-Head Screws

"90% OF THE SCREWS IN THE GRAY AUDOGRAPH ARE PHILLIPS," estimates William S. Sherman, Director of Sales operation. With the introduction of the Phillips self-tapping screw the inspection of each threaded hole has been eliminated. Nor is "head-splitting" or "burring" any longer a factor. Here Mary Borkowski fastens amplifier unit to main frame with Phillips screws.

THE CLARK CONTROLLER COMPANY makes some highly specialized control equipment on which Phillips screws are used. Their neat, compact appearance enhances the design of the units and their positive gripping action prevents driver slippage that would otherwise mar the surface. "There is no comparison in the beauty of design offered by the attractive Phillips head," states R. Russo, Manager of General Engineering Standards Department. Larry Larkin here installs Phillips screws in a Clark push-button station.



BUCHANAN'S REVOLUTIONARY NEW TERMINAL STRIP uses a specially designed Phillips screw that, according to Albert Mittleman, Plant Superintendent and Production Manager "has enabled us to design our own automatic, hopper-fed assembly machine which permits us to put the sub-assembly of these terminal strips on an assembly line basis." Closeup of this machine is shown above.

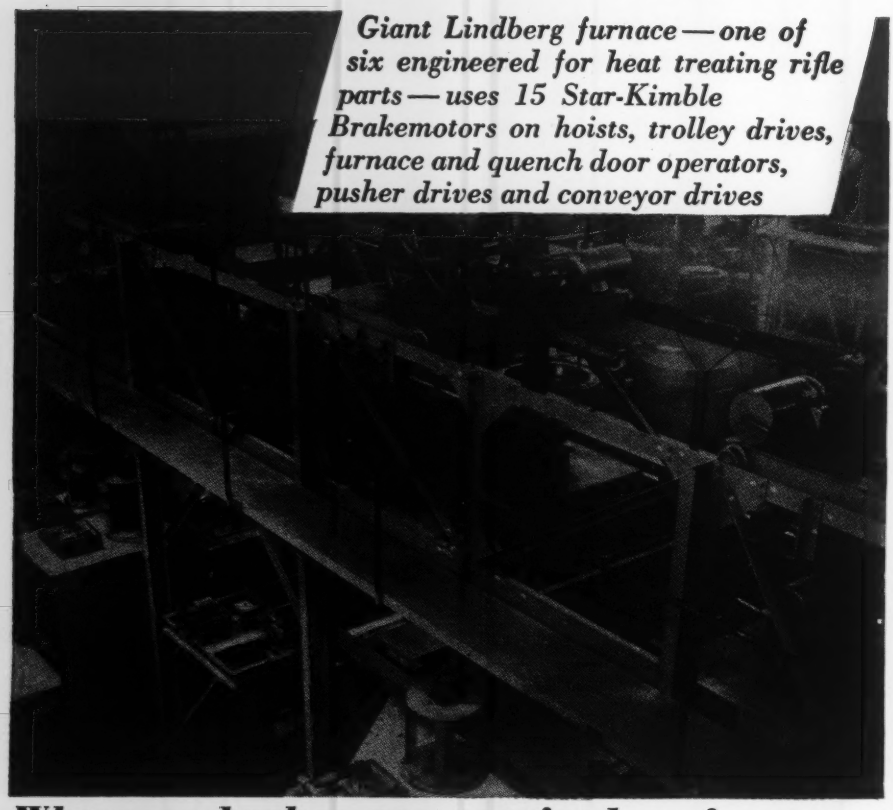
MANUFACTURERS OF PHILLIPS CROSS-RECESSED-HEAD SCREWS

THE FASTENERS OF TODAY... AND OF THE FUTURE

X marks the spot

... the mark of extra quality

American Screw Company • Atlantic Screw Works, Inc. • The Blake & Johnson Co. • Central Screw Company • Continental Screw Company • The Eagle Lock Company Eico Tool and Screw Corporation • Great Lakes Screw Corporation • The H.-M. Harper Co. • The Lamson & Sessions Company • National Lock Company • The National Screw & Manufacturing Co. • Parker-Kalon Div. General American Transportation Corporation • Pheoll Manufacturing Co. • Rockford Screw Products Co. • Scovill Manufacturing Co. • Shakeproof • The Southington Hdwe. Mfg. Company • Sterling Bolt Company • Wales-Beech Corp.



Giant Lindberg furnace — one of six engineered for heat treating rifle parts — uses 15 Star-Kimble Brakemotors on hoists, trolley drives, furnace and quench door operators, pusher drives and conveyor drives

Wherever brakes are required on furnaces,

Lindberg Engineering Co. uses Star-Kimble Brakemotors

BECAUSE

Those are the reasons why Lindberg uses Star-Kimble Brakemotors *exclusively* wherever brakes are needed. When service calls for fast, smooth stop-start cycles — *repeated millions of times* — Star-Kimble Brakemotors will do the job with little or no maintenance attention.

For complete information, write for Bulletin B-501-A.

Standard and special motors of all types, 1 to 125 hp; generators and motor-generator sets, 1 to 100 kw; marine motors, ½ to 125 hp.

Star-Kimble

MOTOR DIVISION

Miehle Printing Press and Mfg. Co.

201 Bloomfield Avenue Bloomfield, New Jersey

Design Abstracts

specifications for electronic timers, the following items should usually be considered:

1. Time range
2. Timing accuracy
3. Contact rating
4. Voltage and temperature effects
5. Reset time
6. Type of operation

None of the foregoing represent information which is difficult to determine but there should be a clear understanding of the terminology employed. For example, specifications on timing accuracy can refer to repetitive accuracy, which means the accuracy with which a timer will repeat a given timed interval, or to calibration accuracy which may mean full scale accuracy or how well the time intervals match calibrated dial settings at a partial time setting. Each of these could also be expressed in terms of a short time accuracy, which would neglect tube drifts or component changes, or in terms of a long time accuracy which would include such drifts.

Accuracy is also definitely tied up with variations in line voltage. It can be defined under conditions of constant voltage or with a voltage variation. Voltage variations may result from gradual drifts such as occur periodically during operation or may be due to transient changes caused by instantaneous load changes.

Photoelectric Relays: In the case of specifying photoelectric relays the following details are most pertinent:

1. Operating distance
2. Percent of light change for operation
3. Contact ratings
4. Number of operations per unit time
5. Response time
6. Effects of voltage and temperature on operation

Assume a photoelectric relay is required to count up to 100 packages per minute on a conveyor and a relay which the manufacturer indicates will operate up to 150 operations per minute is chosen by the designer. He should be on safe ground, but he may have trouble, depending on how the num-

Get on the right track to BEAT WEAR ...use AMPCO* METAL

ONE of the easiest ways to beat wear is to use Ampco Metal. That's why more and more designers and plant-operating men turn to these versatile aluminum-bronze alloys. They know that Ampco Metal builds extra toughness and stamina into their machines — toughness and stamina that mean longer service life, more dependable performance, lower costs.

And unusual resistance to wear isn't the whole story. Ampco Metal has high compressive strength — doesn't squash out. It resists abrasion, erosion, corrosion. It has high impact and fatigue values, and excellent bearing qualities.

You can get Ampco Metal in practically any form you need—sand and centrifugal castings, sheet, plate, forgings, bars, tubes, welding wire and electrodes.

Beat wear! Use Ampco Metal in both your product and plant — for that all-important extra margin of safety and dependability. For the complete story, contact your nearest Ampco field engineer or send coupon.

*Reg. U. S. Pat. Off.

Nordberg Mfg. Co.
Milwaukee, Wisconsin

The Product: Nordberg Hydraulic Power Jack used to lift rails and ties from roadbed during reballasting or resurfacing.

The Problem: To keep wear in the moving parts of the hydraulic rams to a minimum. Because the piston and gland act as guides, close tolerances must be maintained. In addition, the hydraulic ram utilizes pressures of 3000 psi and, although the piston ram has "O" rings with back-up washers, extremely close fits must be maintained between piston and gland to hold this pressure.

The Solution: AMPCO METAL for both piston and gland.

The Results: Thanks to the ability of Ampco Metal to resist wear, proper clearances and tolerances are maintained. The result — dependable performance, greater output.

IT'S PRODUCTION-WISE TO AMPCO-IZE

Nordberg Track Jack in operation. Machine consists basically of two hydraulic rams, each capable of lifting 24,000 lbs. Ampco Metal is used in the moving parts of the hydraulic rams because of its excellent resistance to wear.

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D-13A

SKINNER V5-3 THREE-WAY SOLENOID VALVES

NOW with "QUICK EXHAUST"

Operates twice as fast!

COMPACT
LEAKPROOF
TROUBLE-FREE

Skinner engineers have now added to Skinner V5-3 Series Valves a new feature that assures faster operation of machinery than is possible with Standard V5-3 valves. It's "Quick Exhaust" — achieved through utilization of pressure differentials and a quick exhaust orifice ⅛" in diameter. "Quick Exhaust" speeds up the return stroke of small air and hydraulic cylinders . . . boosts operating speeds.

Skinner V5-3 Quick Exhaust valves are three-way, normally closed. Their soft, synthetic plunger inserts and positive, spring-loaded operation assure leakproof performance — *through millions of cycles.* Bodies and internal parts are made of stainless steel. Moisture-resistant, varnish-impregnated coils are another quality feature.

Valves of this series are compact — precision-built yet rugged — designed and manufactured to give years of dependable service.

SPECIFICATIONS

Pressure Ratings	50, 75, 100, 150 P.S.I.
Orifice diameters	⅛", 3/32", 1/16", 3/64"
Secondary exhaust diameter	3/32"
Pipe Size	⅛" or ¼" NPT
Voltage	All common AC, DC Voltages
Power Consumption	9 Watts Maximum

Write for Bulletin 530

TYPICAL SKINNER VALVES

M3 – three-way Pilot Operated 5-150 p.s.i.

V10 Hydraulic 0-1000 p.s.i.

X5 Explosion Proof 0-1000 p.s.i.

V2 two-way Stainless Steel 0-200 p.s.i.

V5-2 two- and three-way Industrial 0-1000 p.s.i.

V9 Four-Way 50-150 p.s.i.

Write for information about our complete line.

SKINNER ELECTRIC VALVES — THE CREST OF QUALITY

SKINNER SOLENOID VALVES

THE SKINNER CHUCK COMPANY
115 EDGEWOOD AVENUE, NEW BRITAIN, CONNECTICUT

Design Abstracts

ber of operations per minute were determined. Actually the number of operations per unit time that this relay will perform satisfactorily depends on the relay response time, pickup time and drop-out time. For example, in *Fig.* 1*a* package size causes relay energizing for half the time, where drop out occurs when a package interrupts the light beam. In this case

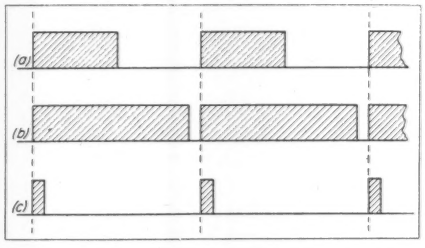


Fig. 1—Possible conveyor package arrangements represented by shaded blocks indicate need to evaluate response characteristics for a photoelectric counter with regard to size range of objects to be counted

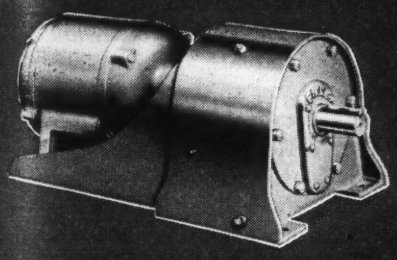
the photoelectric relay would have little difficulty in picking up and dropping out properly. For long packages, *Fig.* 1*b*, the relay is energized for a short time. If relay response is not fast enough, the relay will not operate satisfactorily regardless of whether the number of counts per minute is 100 or 150. Where the objects to be counted are small, *Fig.* 1*c*, a short drop-out time for the relay is necessary in order to give an accurate record of the number of units per minute.

Closed-Loop Control: The need for common terms, definitions and standard of performance is of increasing importance in the field of closed-loop control. In this system of control, performance is measured against a reference and is constantly maintained within certain prescribed limits. A simple block diagram, *Fig.* 2, indicates a closed-loop control system where reference and feedback voltages are compared at the summing point and the difference or actuating signal is employed to control system elements which in turn

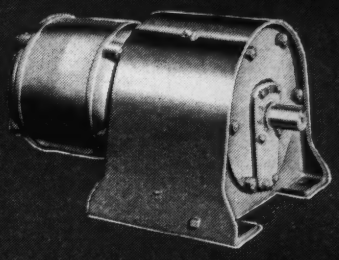
ALL-STEEL FALK Motoreducers

many types, sizes, styles, arrangements . . .

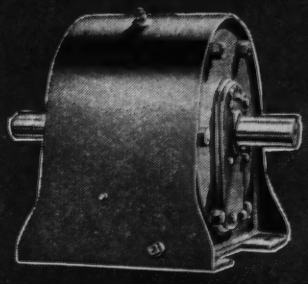
cover the entire application range



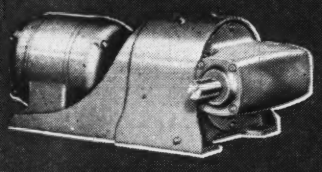
Type EZ, All-Motor Horizontal Motoreducer. Accommodates any make or type of foot-mounted motor.



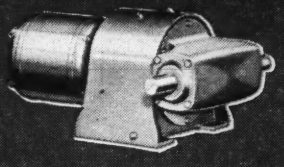
Type EF, Integral Horizontal Motoreducer. Standard NEMA D-flange motor mounts directly on Motoreducer housings.



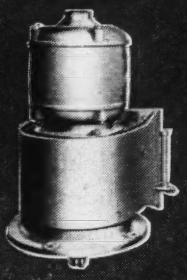
Type EC, Concentric Shaft Speed Reducer. Coupling, chain or belt driven.



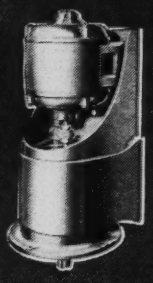
Type EBZ, All-Motor Right Angle Motoreducer. Any output shaft position (see below, right).



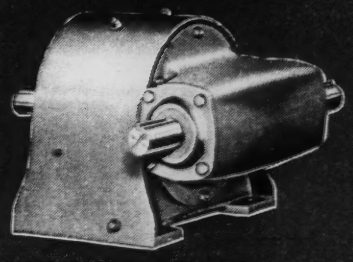
Type EBF, Integral Right Angle Motoreducer. Employs NEMA D-flange motor.



Type EFX, Integral Vertical Motoreducer. Employs NEMA D-flange motor.



Type EZX, All-Motor Concentric Motoreducer. For vertical applications.



Type ECB, Right Angle Speed Reducer. Any output shaft position; coupling, chain or belt driven.

VERSATILE MEMBERS OF A DISTINGUISHED FAMILY

The name FALK on a reducing unit of any size or type is a positive guarantee of highest quality, value and efficient performance with minimum maintenance throughout its long life.

All-steel FALK Motoreducers—both the All-Motor and Integral types—are available in horizontal and vertical models with double, triple or quadruple reduction; concentric and right-angle shaft arrangements. They cover a surprisingly wide range in horsepowers and in output speeds. Every FALK Motoreducer is built and rated according to AGMA standards.

Whatever reduction requirements are involved in the industrial equipment you manufacture, it is just good business to consult FALK, recognized leader in the Motoreducer and speed reducer field. Write to Department 247.

Every FALK Motoreducer has these "IN-BUILT" Factors

All-steel Housings. Unbreakable, strong, rigid. Generous overhung load capacities provided by wide bearing spans, large shafts and bearings.

Precision Gearing. Heat-treated alloy steel, precision cut and shaved helical gearing throughout . . . quiet-operating crown shaved pinions . . . taper bored gears for easy ratio changes.

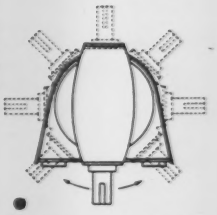
Sealed Housings. Dual closures and one-way vents keep oil in, dust and moisture out. Units are splashproof, leakproof, dustproof.

Wide Speed Range. Selective ratio combinations provide output speeds from 1.5 rpm to 1430 rpm with stock gears.

Streamlined inside and outside. Smooth, clean surfaces; machine welded construction conforms to NEMA motor frames.

Positive Lubrication. Large sump capacity . . . oil-tight construction assures clean lubricant . . . direct dip of revolving elements provides positive lubrication at all speeds.

Any Output Shaft Arrangement (on Right Angle models). Shafts can be furnished in horizontal, vertical or angle position as shown in sketch at right.



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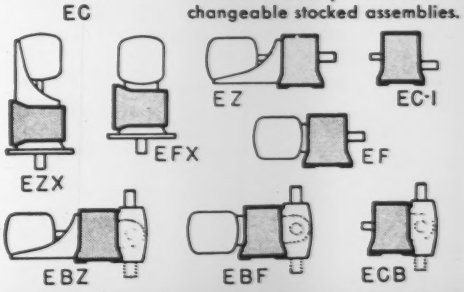
EC

The basic E design permits maximum use of standardized parts . . . closer control over materials, processing, inspection and assembly . . . resulting in faster delivery from interchangeable stocked assemblies.



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THE FALK CORPORATION, 3001 W. Canal St., Milwaukee 8, Wis.

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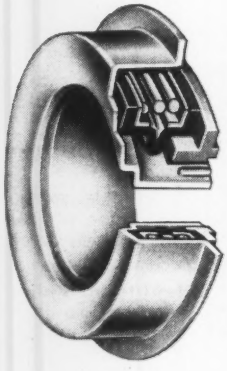
can supply the exact seal you require

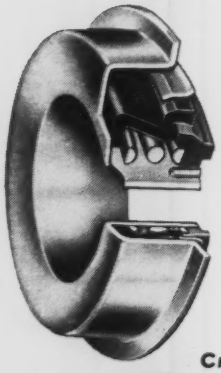
You can achieve the sealing efficiency you want . . . eliminate specification problems . . . work unhampered from drawing board to production—when you work hand-in-hand with "John Crane's" experienced engineering staff and available facilities.

Get quick, finger tip information on "John Crane's" complete line of high production mechanical seals—for every conceivable service—to meet your particular needs. Send now for illustrated technical catalog. It's your's upon request.



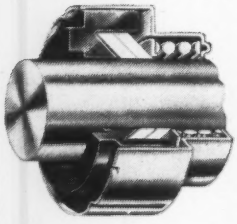
TYPE 6-A

Pressed-in packaged unit recommended for small shafts on hot or cold water, oil, gasoline or soapy liquids . . . pressures to 75 psi . . . temperatures from —65° F. to +220° F. Available in stainless steel or bronze.



TYPE 11-A

Pressed-in packaged unit with spring inside synthetic rubber bellows to protect against corrosion. For hot or cold water, oil, gasoline or soapy liquids . . . pressures to 35 psi . . . temperatures from —65° F. to +212° F.



TYPE 19

An all-purpose seal suitable for handling practically any liquid or gas, including highly corrosive acids and oils.

Low or high temperatures from —100° F. to +450° F. . . . pressures to 200 psi. Incorporates highly efficient sealing cones made of Du Pont's Teflon, which is inert to practically all chemicals.

Crane Packing Company, 1825 Cuyler Ave., Chicago 13, Illinois

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JOHN CRANE **CRANE PACKING COMPANY**

Design Abstracts

control the regulated variable.

An example of closed-loop control is provided by a single-dimension contouring control system for a lathe. The controls must automatically guide the lathe to reproduce a given part from a template or pattern. The system elements include a template, which is the reference, and a tracer head with a stylus that feels the template and by the deflections of the stylus gives actuating signals to the control and power amplifier which in turn drives the motor. The motor is directly connected to the lead screw which repositions the stylus of the tracer and keeps its signal commands within limits determined by several factors including system sensitivity and frequency response. Since the tool and the

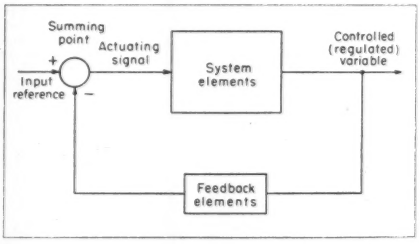


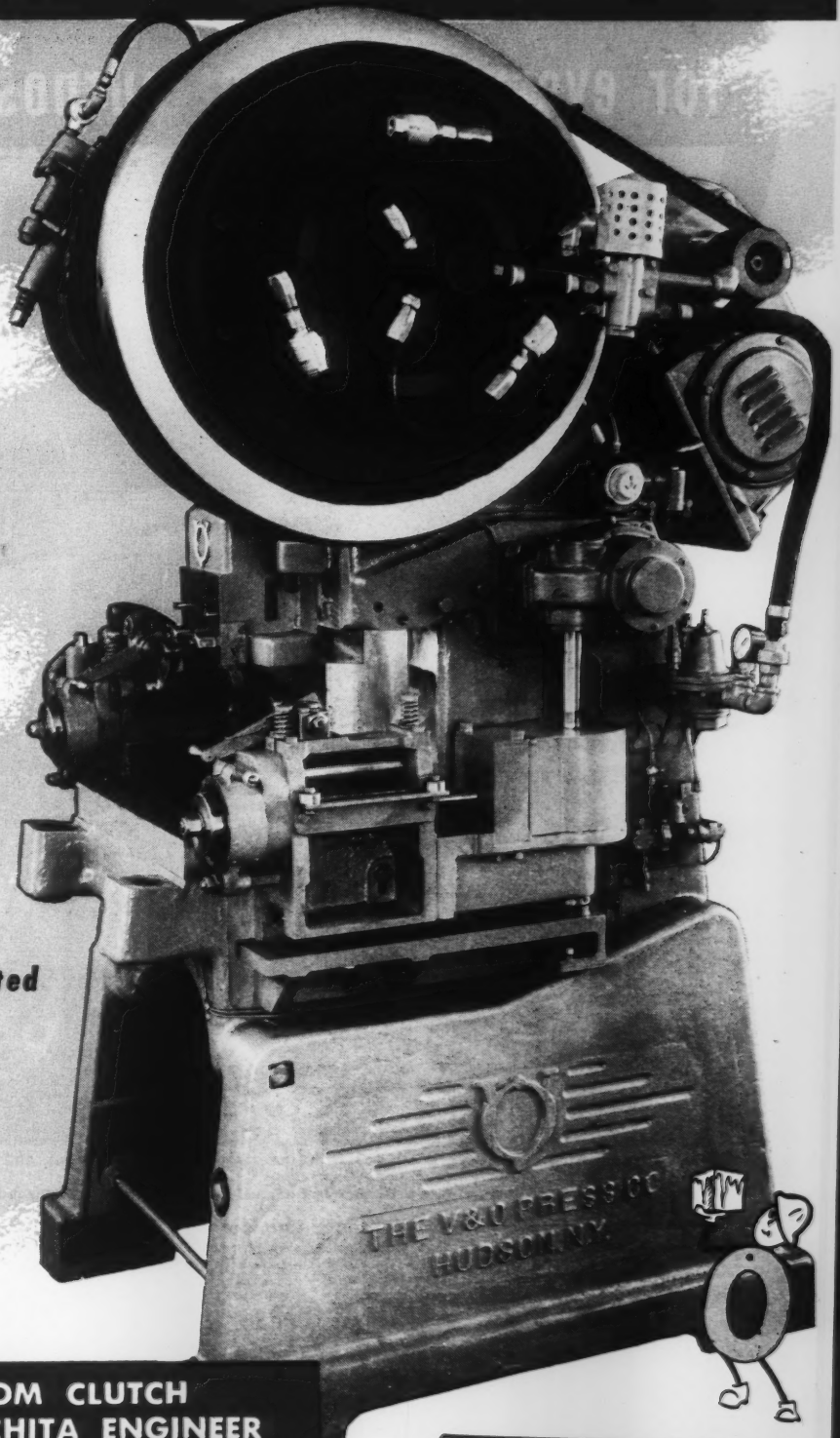
Fig. 2—Diagram of elements in a simple closed-loop control system

tracer are mechanically tied together, the tool is also automatically repositioned as the tracer is moved with respect to the template. In this way, the template outline is automatically reproduced by the cutting tool. The tie between the tracer head and the stylus is mechanical and is determined by the stylus length and the material used. The ties between the tracer head and the control and power amplifier are all electrical. The ties between the motor, tracer head, and the tool are mechanical as are the ties between the template and the machine.

Mechanical deficiencies bear equal importance with such control factors as frequency response, sensitivity, velocity error coefficient and cutoff frequency. Various mechanical faults may be minimized by proper design of control systems, but this effect can not be

Wichita...the Answer to

CLUTCH PROBLEMS for HIGH SPEED OPERATIONS!



To have perfect control on high speed presses operating at 450 Strokes Per Minute, clutches must disengage very quickly, because the elapsed time is extremely short between the ram at the bottom and at the top center. This is a major requirement on 45 ton V & O High Speed Presses. Because Wichita 18" Low Inertia Clutches are the answer to this and many other press clutch problems . . . WICHITA CLUTCHES WERE SELECTED.

In addition, the extremely fast action, of Wichita Clutches and Brakes, is ideal for inching (or jogging) and single stroke operation.

The Wichita Clutch on the press pictured here has been operated in excess of 100 engagements per minute WITHOUT DEVELOPING ANY TROUBLE . . . HEAT INCLUDED!

WICHITA Low Inertia, Positively Ventilated CLUTCHES Will Eliminate:

- **Heat Problems**
- **Adjustment Problems**
- **Lubrication Problems**
- **Centrifugal Force Problems**
- **Self Energization Problems**

TO GAIN MAXIMUM EFFICIENCY FROM CLUTCH OPERATION SEE YOUR NEAREST WICHITA ENGINEER

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Ad – 13

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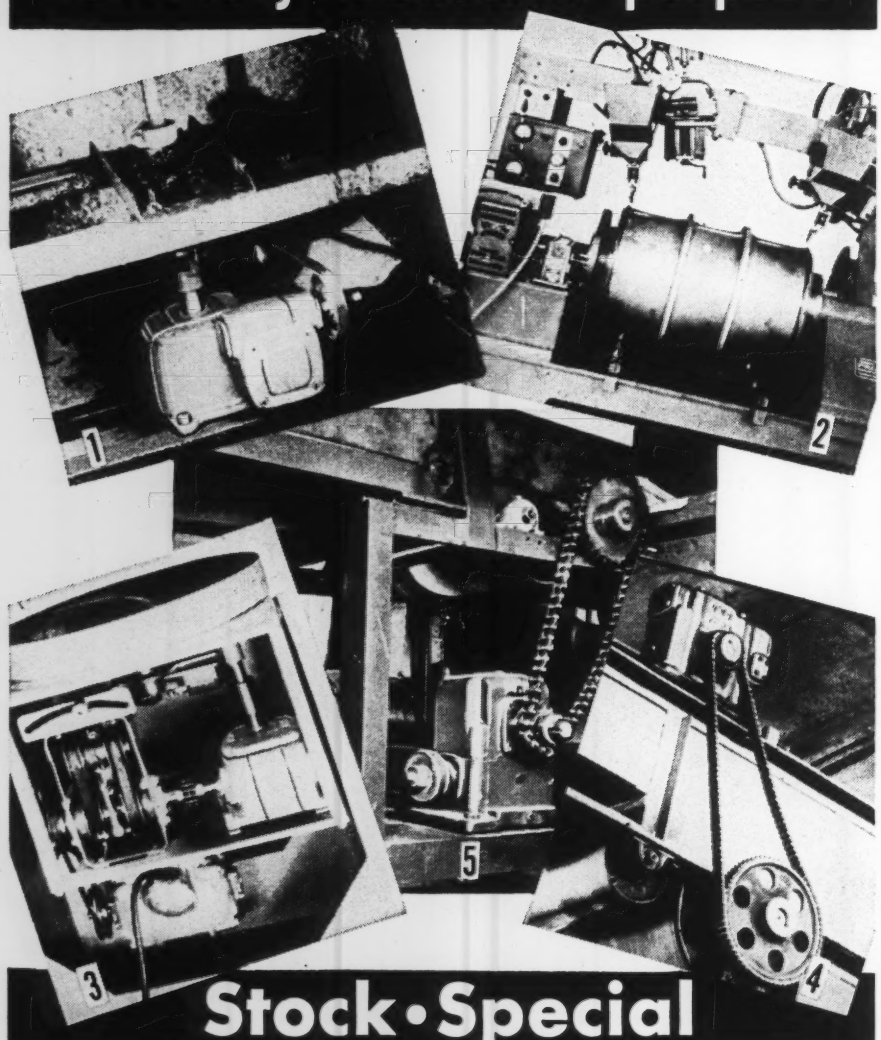
for every industrial purpose



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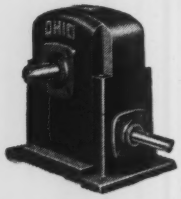
Years of engineering experience, combined with the most modern equipment and quality materials go into the manufacture of Ohio Gear speed reducers.
Every detail of production and workmanship is designed to insure accuracy, durability and years of trouble-free operation.
Illustrated above are a few applications by large manufacturers who depend on Ohio Gear.

1. Ohio Gear DPL Speed Reducer operating a paint booth turn-table in a large metal working plant.
2. Ohio DS Speed Reducer, 300 to 1 ratio, used in the drive of a machine which automatically welds both heads into the shell of a 55 gallon barrel.
3. A PL2 Reducer, 40 to 1 ratio, operating the turn-table of a machine automatically welding automobile crankshaft vibration dampers.
4. Ohio Gear DHU Speed Reducer operating an overhead scrap conveyor belt in a large die casting plant.
5. Series of Ohio Gear HS Speed Reducers operating conveyors in a California fruit packing plant.

Consult your nearest distributor or write us for complete information.



ESTABLISHED 1915

OHIO GEARS

THE OHIO GEAR COMPANY, 1338 East 179th St., Cleveland 10, Ohio

Design Abstracts

eliminated and may seriously limit the performance of a system. The responsibility for successful operation of a servo system rests clearly in the hands of the machine designer.

Often the machinery manufacturer wants a performance specification which says without qualification that the system has a certain accuracy and speed of travel. Furthermore, he feels that by specifying a certain velocity error coefficient and a certain cutoff frequency, the remaining items are insignificant. That is not so. While it is fully agreed that specification of control must be clearly defined, so must the limits of responsibility. Likewise, the machinery manufacturer must be aware of his responsibility to build satisfactory servo characteristics into the machine if greater success is to be achieved and full benefits are to be derived from electronic controls.

From a paper entitled "Performance Specifications are Needed for Electronic Control" presented at the AIEE Winter General Meeting in New York, N. Y., January, 1954.

Planning Engineering Projects

By Robert G. Nightingale

Director of Engineering
Wheeler Associates Inc.
Cleveland, O.

DESIGN, development and eventual successful production of a new and better product requires the full co-operation of all departments in a company. The engineering department is charged with the task of translating ideas into tangible products, processes or systems which will be saleable items. Problems must be solved on the basis of the limits established by management, competition, price, product functions, etc.

In designing and manufacturing a new or redesigned product, an organized overall engineering approach is perhaps best outlined by the following steps:

1. Definition of product.
2. Study or research of feasibility

SPEED KING

SOLENOID PILOT OPERATED CONTROL VALVE

by VALVAIR

DESIGNED AND BUILT TO J. I. C. STANDARDS

- **A Hefty Assist to Automation**
- **Fully Enclosed**
- **Integral Junction Box**

The Valvair line broadens again — with Speed King's exclusive features. All parts are totally enclosed. The Speed King will operate submerged in water or buried in sand. Simplicity! — only two moving parts. Molded coil — no wear or shorting out. 20,000,000-cycle life and more. Speed King is industry's most rugged and compact valve.

Other features: for pressures from 35 to 200 p.s.i. pneumatics, hydraulics, vacuum; complete line—2-way, 3-way, 4-way and 4-way-5-port (2-pressure) models; foot or sub-base (manifold) mounting; pipe sizes —¼", ⅜", ½", ¾", and 1".

Ask for Bulletin "D-6".

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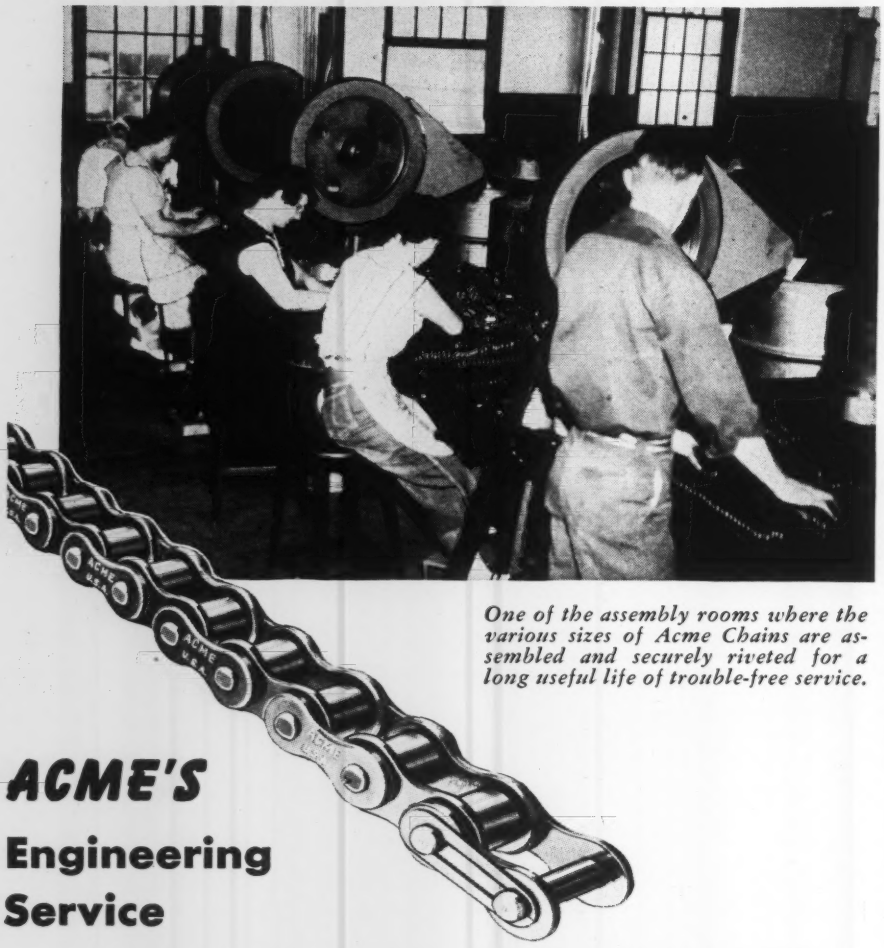
VALVAIR CORPORATION *Affiliate: Sinclair-Collins Valve Company*
953 BEARDSLEY AVE., AKRON 11, OHIO

Rely Upon Valvair DIVERSATILITY

No. 5 - Precision Operations in the Manufacture of ACME Chains



One of the assembly rooms where the various sizes of Acme Chains are assembled and securely riveted for a long useful life of trouble-free service.

ACME'S
Engineering Service
AT YOUR COMMAND

Whenever you are in doubt about engineering details in designing machinery in which Roller Chains are used, call us up. Our engineers will gladly work shoulder to shoulder with your designers to work out the details of sprocket, ratio, chain impact, tension, drive speed and other factors necessary to obtain the maximum efficiency and economy on your project.

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Write Dept. 6-J for new illustrated 76 page catalog on use and application of roller chains and sprockets.

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

Design Abstracts

of new product.
3. Determination of general arrangement and preliminary design.
4. Construction and testing of prototypes.
5. Cost analysis.
6. Tool analysis.
7. Design for production and release.
8. Preliminary production run (tool tryout).
9. Post production changes.

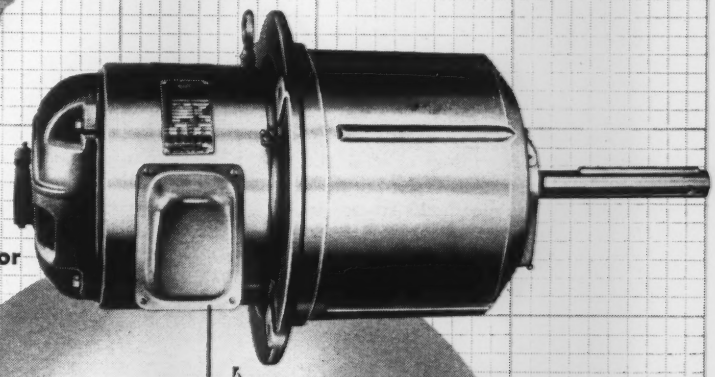
To carry out these steps, engineering management must have the personnel and facilities to do an adequate job commensurate with the company budget and policies. The chief engineer, engineering manager, or whatever name is given to the individual responsible for the engineering functions, must have a planned procedure and organization to analyze the data obtained in the first three steps. He must then be willing and able to sell his superiors on the needs of his department and its ability to produce the work in the time required.

As is usually the case, the first step is the most difficult in attacking a new problem. The chief engineer must get the problems or tasks defined, not for just this week or this month, but for at least 6 months if the work load is to be efficiently handled. A sales forecast must be made for a much longer time than engineering requires because it is also used by the works manager to plan tooling, new equipment, material procurement, plant layout, and personnel assignments and training.

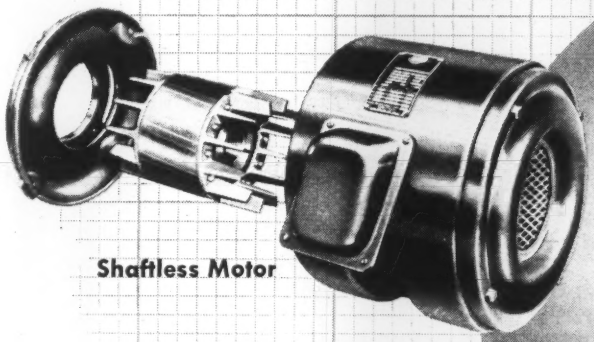
Defining the Product: If a firm product description is available at the start, the chief engineer is indeed fortunate. However, this is usually not the case. Experience shows that names and one sentence descriptions of new products or of changes in a product do not define the task. A complete specification or description of the product is an absolute necessity. The specification will vary with the product and company experience in that line, but it must define the product as to performance, test requirements, desired materials, cost limits, anticipated production (both annual and

a motor designed for its job

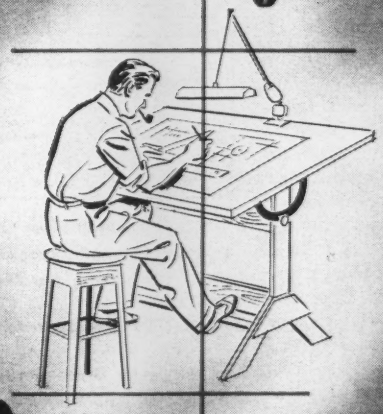
will out-perform a "standard"

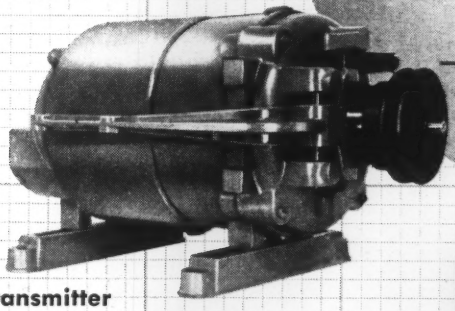


Special Purpose
Extended Bearing Motor

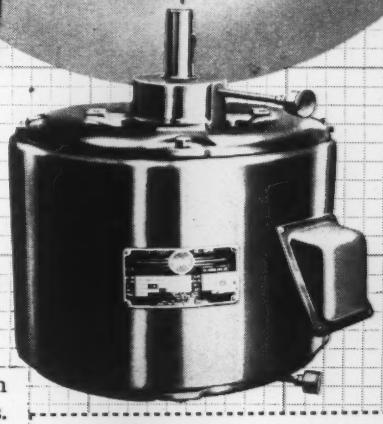


Shaftless Motor





Power Transmitter
(Clutch-Brake Motor)



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Vertical Motor

No standard motor can hope to match performance with a motor custom designed to meet unique requirements.

That's why Diehl lays so much emphasis on custom construction . . . why, through the years, it has geared its abilities and its facilities, its design, engineering and manufacturing functions for maximum cooperation with its customers . . . whatever the application.

DIEHL custom-tailored motors can:

Cut costs • Save space • Reduce weight • Improve safety
Simplify design • Speed production • Improve appearance

When you want a fast, thorough answer to an unusual motor problem it will pay you to consult Diehl. Name your conditions . . . Diehl will design and build to match.

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Electrical Division of THE SINGER MANUFACTURING COMPANY
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☐ New Type "D" Motor Bulletin No. MD-3304
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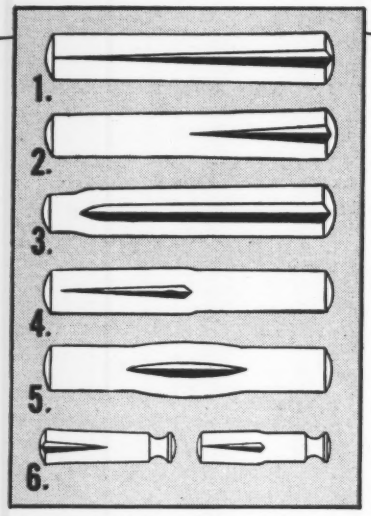
INTEGRAL AND FRACTIONAL HORSEPOWER MOTORS ARE AVAILABLE IN A WIDE RANGE OF TYPES AND SIZES

No better press fit pin fastener has ever been devised than the original GROOV-PIN

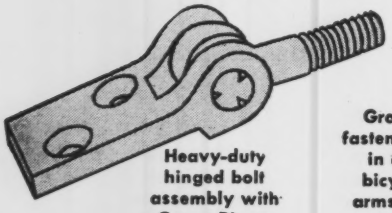
The Groov-Pin is primarily a cylindrical pin cut from bar or coil stock. Longitudinal grooves are rolled or pressed into the body to deform the stock within controlled standard limits.

When the Groov-Pin is forced into a drilled hole of correct diameter, the constraining action of the hole wall causes the displaced material to flow back and make a locking fit within its elastic range. Resiliency of the pin stock makes it practicable to use the same pin repeatedly.

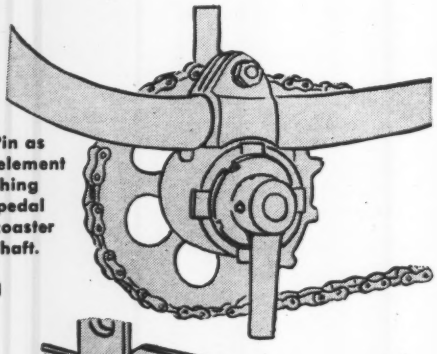
The Groov-Pin is simple in design, efficient, economical both in price and in cost of application, and it is versatile in its uses. This combination of advantages has never been surpassed by any other pin fastening. It is true even though Groov-Pins have been in use for over a quarter-century, essentially in their present form from the beginning. Like the common pin or nail the original design of the Groov-Pin was fundamentally perfect. Therefore, improvement has been impossible. Groov-Pins are assembled in straight drilled holes. No tapping, reaming, peening or milling are required. They can be driven by hand hammer, air cylinder or hydraulic press.



1. Full length taper Groov-Pin.
2. Half length taper Groov-Pin.
3. Full length parallel Groov-Pin.
4. Half length reverse taper Groov-Pin.
5. Center Groov-Pin.
6. Half length taper and reverse taper Groov-Pin with annular grooves for spring retention.

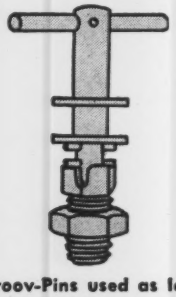


Heavy-duty hinged bolt assembly with Groov-Pin as hinge pin.

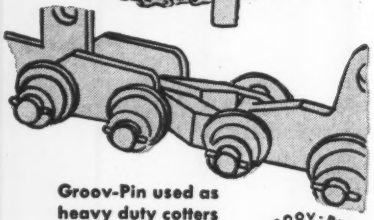


Groov-Pin as fastening element in attaching bicycle pedal arms to coaster brake shaft.

Groov-Pin used as cross pin in stud of cowling fastener.



Groov-Pins used as locating and stop pin and for locking handle in pressure relief valve stem.



Groov-Pin used as heavy duty cotters on heavy chain links.

GROOV-PIN
TRADE MARK REG U.S. PAT OFF

GROOV-PIN CORPORATION

1129 Hendricks Causeway, Ridgefield, New Jersey

Design Abstracts

single run) and desired schedule. It isn't practical, of course, to expect the engineering and production departments to estimate in advance the needs of the sales department.

It has been found necessary under current conditions to closely control and schedule the work load imposed on the engineering department. This means management controls to eliminate short term planning with consequent peak loads and crises. One useful method of attack is the "project order system." Its primary functions include the following:

1. Furnish cost and delivery estimates for new products.
2. Authorize engineering and manufacturing departments action after approval by management.
3. Designate accounting charge order numbers.

In most cases, it is necessary to further subdivide each of these functions into three product phases; namely, (1) design proposal, (2) experimental or prototype samples and (3) production order. Ideally, the sales department should submit a sales estimate to support its request for each phase of the project.

After review, comment and filling in of cost and delivery estimates by engineering and manufacturing departments, the project order is submitted for approval by management. Priority on the schedule is settled at that time. It should be noted that this project order provides an opportunity to record actual labor and material expenditures. These are a useful guide for future estimates. Many pet projects are discouraged or completely eliminated by a review of estimated costs.

Design Proposal: In preparing the design proposal, a study of current literature, patents, and competitive products is useful, as is commonly realized. If the design proposal is acceptable to the sales and manufacturing departments, one or several "mock-ups" or non-operating samples should perhaps be made to give a visual and dimensional check of the product. A meeting of the sales, manufactur-

Current Limiting Fuses Clear Short Circuits in Less than ½ Cycle

Type H Starters

FOR 1300 TO 3000 VOLT MOTORS

With Allis-Chalmers Type H Starters, your motors, cables and associated equipment are protected against short circuits by fast-acting current limiting fuses. These fuses cut off short circuit current at a *low safe peak value.* The short is cleared in less than a half cycle . . . thus minimizing the possibility of damage.

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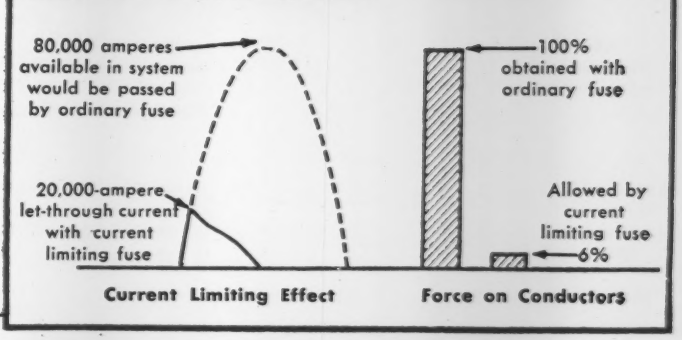
Action is silent. An indicator in the end of fuse reveals occurrence of short. Blown fuse emits no gas, flame nor vapor . . . discharges no metal. Flashover caused by ionized vapor is eliminated. Fuses will not blow unnecessarily . . . protection against locked-rotor or single-phase conditions is provided by overload relays coordinated with fuses.

The FULL Protection Starter

Quick action short circuit protection is a part of the *Full Protection* engineered into a Type H starter . . . complete, positive protection which permits men to work in safety, guards motors and machines against costly damage, lengthens equipment life, increases production by reducing down time. Get all the facts from your nearby A-C representative or write Allis-Chalmers, Milwaukee 1, Wisconsin.

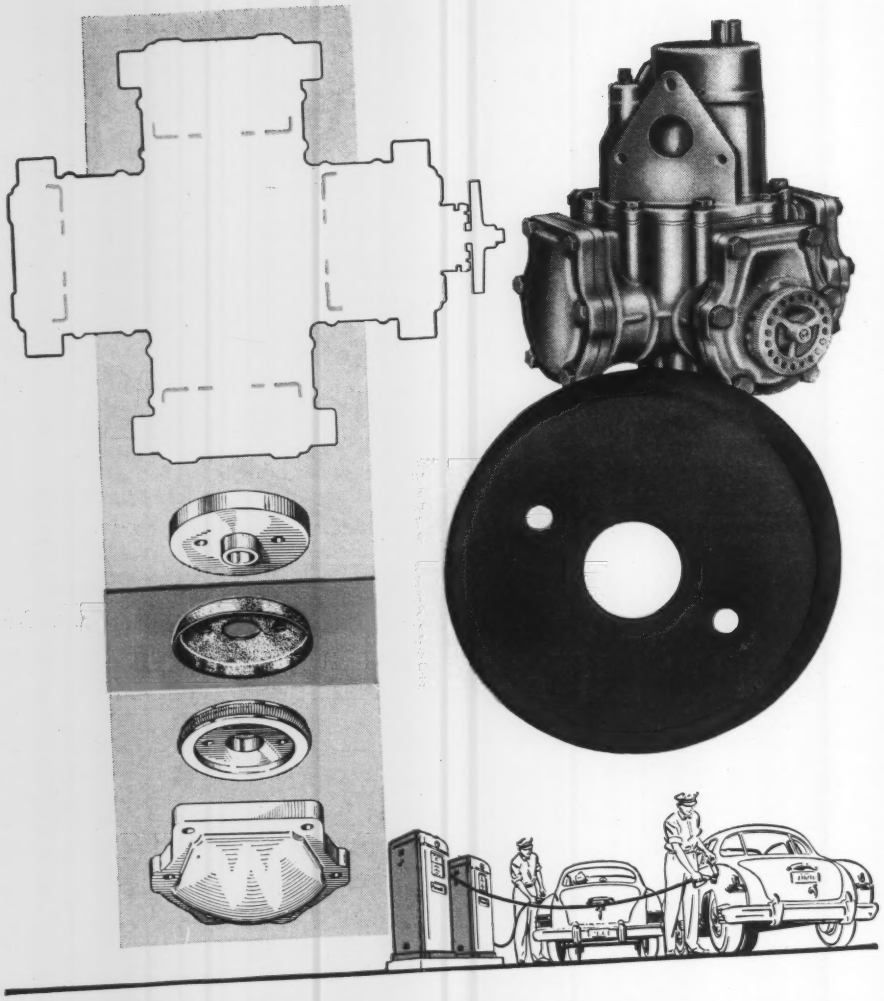
A-4368

Compare . . .



A-C ALLIS-CHALMERS

ALLIS-CHALMERS



How G&K-INTERNATIONAL helps Gilbarco Pumps meter gasoline with "Split drop" accuracy

The Gilbarco four-piston positive displacement meter is as nearly frictionless as any mechanism can be. You can spin it by blowing your breath into its inlet port. Yet the four pistons operate in positive leak-proof contact with the cylinder walls.

The problem is solved with four leather cup packings, coated inside to prevent the penetration of the gasoline. The cups must not vary in any dimension more than .0025 inch — a real achievement when working with leather.

Meeting *required accuracy* and *scheduled deliveries* are two *"musts"* at G&K-INTERNATIONAL. That's why you, like Gilbert & Barker Manufacturing Company, can depend upon this source for your packings in modern leather Cups, Flanges, U's, V's and Oil Seals; and in standard or special synthetic rubber packings of all types, including O-Rings.

Write for G&K-INTERNATIONAL Catalog and Manual 201-A. 60 pages of up-to-date data including latest JIC and officially recommended sizes for all types of packings.

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LEATHER — SYNTHETIC RUBBER

P-3

GRATON & KNIGHT COMPANY, Worcester, Massachusetts
INTERNATIONAL PACKINGS CORPORATION, Bristol, N. H.

Design Abstracts

ing and engineering departments will determine the future course of action at this phase and possibly enlarge and clarify the specification.

Experimental Samples: This phase has often been omitted with disastrous results. Test specimens or prototypes should be made and subjected to tests under controlled conditions employing discretion not to impose excessively severe requirements.

While the prototypes are being tested, manufacturing and estimating departments have an opportunity for their analysis. Uneconomic and difficult manufacturing items can be caught in time for corrective action to be taken. Existing methods, tooling, machines, processing and time studies can be checked to prevent future headaches in production. Also, estimates of the cost of the product, tooling and the time required can be made. This information permits the engineering department to make a reasonable estimate of changes from prototype to production. These data when submitted with the test results enable management to make an intelligent decision on the proposed product. If the decision is to proceed, the specifications should be up-dated and the production order released to manufacturing for action.

Production Order: At this phase the manufacturing department has a big job to do. Engineers often do not seem to realize its magnitude, perhaps because they are engrossed in getting the drawings made and released. Too often the engineering department holds drawings until all are completed before releasing them to the production control and tooling departments. The result is loss of valuable time, since the more elaborate and difficult parts require a much greater lead time. Establishing an advance material list for each project helps to expedite the work of other departments such as tooling, purchasing and manufacturing. Probably all of us have experienced delays because of late release of forgings, stampings, die-

SURFACE DECARBURIZATION PROBLEMS ... ELIMINATED in INVESTMENT CASTINGS by ARWOOD'S new Homocarb Furnace

Design Engineers

Arwood can investment cast intricate or simple shapes at great savings with the assurance of uniform quality — we can guarantee castings with .001" maximum decarburization.

Here's How

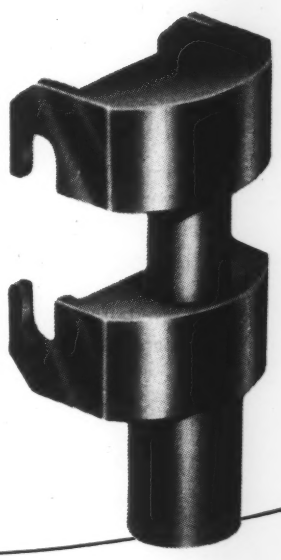
Arwood has pioneered again — recognizing the need for investment castings free of surface decarburization, Arwood is the first foundry to install carbon restoration equipment.

NOW...

Carbon and low alloy steel investment castings (1020, 3120, 4130, 4140 and 6150) can now meet all of the most exact metallurgical specifications — including freedom from surface decarburization.

Let ARWOOD *help YOU*

solve your production problem — improve your design — save you money — assure you top quality. Drop us a line to have one of our field engineers call on you and discuss how you can best utilize Arwood investment castings.



For the RECORD

These two mating units, pilot and anchor for aircraft clamp ring fastening screw, were previously milled from bar stock.

Using the carbon restoration unit, Arwood was able to meet the strict metallurgical specifications necessary to assure dependable performance.

ALLOY: 4140 (.001" Max. Decarb.)
HEAT TREAT: Double normalize, carbon restore, quench, temper
HARDNESS: Rc 25 Max
COST: 22.5% of machined cost

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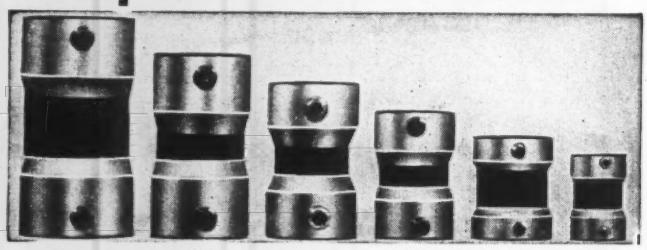
PRECISION CASTING Corp.
78 WASHINGTON STREET B'KLYN 1, N. Y.
Plants: Brooklyn N.Y. · Groton, Conn. · Tilton, N.H. · Los Angeles, Cal.

Needed: A "Wasp Waist" with "REACH"

specify Guardian FLEXIBLE COUPLINGS...



#4 #3 #2 #1 #0 #00

Freedom of the designer to select and specify the exact length the drive requires—plus very low overall diameter of coupling for the capacity it carries—these are reasons for more and more Original Equipment Manufacturers specifying Guardian Dyna-Line Couplings.

Guardian molded DuPont's nylon Splined Sleeve couplings, now available in No. 1, 2 and 3 Series (1/6, 1/3, 3/4 HP @ 1750 RPM), provide instant absorption of lateral motion and adjustable positioning. In "tight spots" of difficult final assembly, the nylon sleeve locates, centers and mounts quickly and easily onto its grooved mating hub.

Our Product Application Department will welcome the opportunity of serving you.

HERE...

FROM OUR PRODUCT APPLICATION FILE

Case History No. 23-3

PROBLEM: Compacted design of a motor driven hydraulic control system required a flexible coupling not over 1¼" O.D. at any point, to couple motor and pump shafts spaced 2¼" apart: Must carry ¾ HP 1750 RPM motor load.

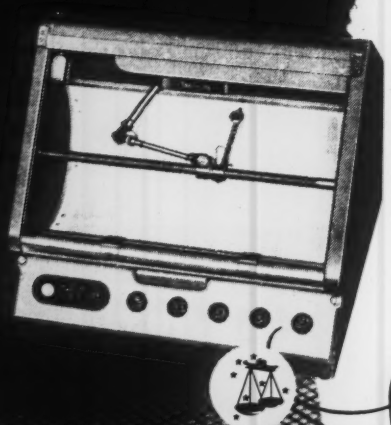
SOLUTION: Guardian Dyna-Line No. 3-R 4.25" long with Standard Flex-Element serves this Original Equipment Manufacturer's requirements. This length specification carries no *"premium price for non-standard length"*.

Write for Catalog Page C102 and Drive Data Form #53.

Guardian PRODUCTS CORP.
COUPLING DIVISION
Dept. IC-M, 1215 E. Second St., Michigan City, Ind.

Guardian
QUALITY IS TRUE ECONOMY

X-Y PLOTTER AND RECORDER



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1607 FLOWER ST., GLENDALE, CALIF.

LIBRASCOPE, INCORPORATED

Design Abstracts

castings, etc., but we often forget that a purchased part such as a special bolt can cause delays. This advance material list can be periodically checked with the production control department to insure that schedules are carefully maintained.

During tooling and the first production run, close contact must be kept with progress in the shop by some member of the engineering staff. His duties are:

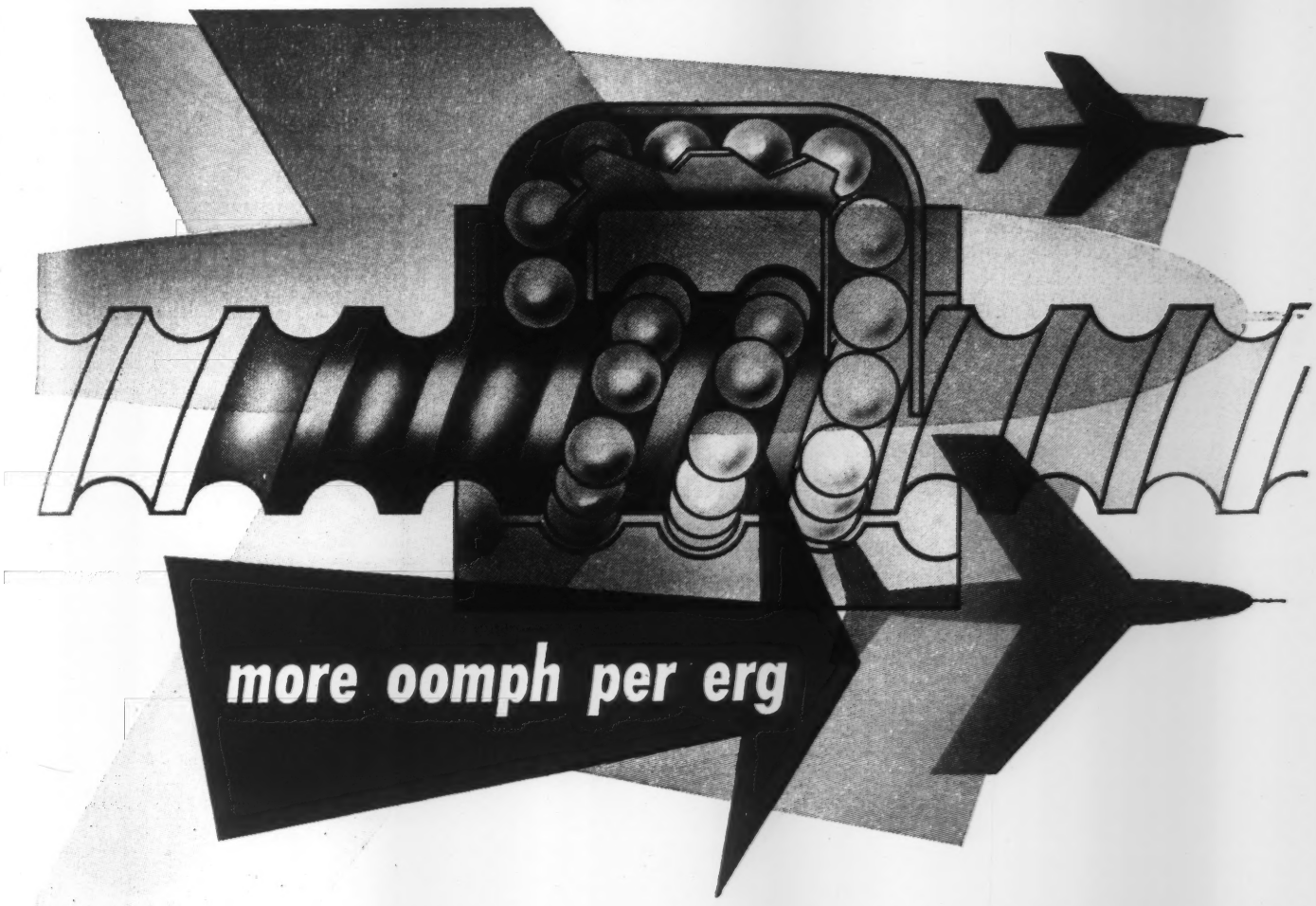
1. Interpret drawings if they are ambiguous or incorrect.
2. Make or approve and record revisions to drawings where additional data are required.
3. Represent the engineering department in salvage or rework discussion.
4. Investigate shop requests for changes and recommend action by the engineering department.
5. Maintain good relations between the shop and the engineering department and co-ordinate activities in the interest of the company.

Decisions on drawings, tools, etc. should be recorded on a reproducible form to ensure that all necessary approvals are obtained.

Final Review: After the first production run has been completed, it is a good time to review the product design, tooling and costs. Meanwhile, the sales department is getting the customer reaction. The liaison engineer should have accumulated and analyzed all deviation and change requests. Labor and cost estimates should be compared with actual costs.

The engineering department must discard the all too prevalent tendency to stand on the correctness of the drawings without regard for the problems of other people. Drawing changes must be approached realistically to benefit the company as a whole. Remember that it costs time and labor to change a tool, a process, or a plant arrangement.

From a paper entitled "Gearing Your Engineering for Today's Needs" presented at the 11th Annual Machine Design Conference sponsored by the Cleveland Engineering Society in Cleveland, O., February, 1954.



To the engineer designing actuators for aircraft controls or virtually any other mechanism, the advantages of Saginaw Ball Bearing Screws are important. These efficient screw assemblies transmit the rotary-to-linear force through rolling steel balls with only a fraction of the torque required for ordinary thread-to-thread screws. Thus, with a Saginaw Screw, the same performance can be obtained with much less power than would be necessary with a thread-to-thread screw. Since modern aircraft require actuators for ailerons, trim tabs, wing flaps, brakes, doors, engine cowl flaps and many other essential controls, the reduced power requirement and the resultant weight savings made possible through the use of Saginaw Screws is of great importance.

Of course, the reduced power requirements of Saginaw Screws is important in many other applications—in machine tools, for example, where an operator must make precise manual or power adjustments of hundreds of pounds of heavy duty equipment; in both the manual and power steering units of automobiles and trucks; or in four-way automobile seat actuators.

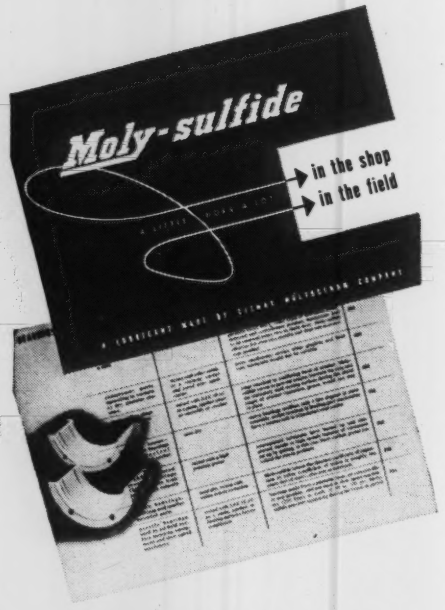
Saginaw Screws can be supplied in a complete range of load and life requirements for use with electrical, hydraulic or pneumatic units. For complete information, write today for our engineering data book.

Saginaw STEERING GEAR DIVISION

71

GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN • MANUFACTURERS OF SAFETY POWER STEERING

154 ideas on ways to use...



154 varied applications of molybdenum sulfide in the shop and in the field are described in a new booklet now available. This solid-film lubricant has demonstrated unique anti-friction properties under conditions of extreme pressure, high velocity, elevated temperature, or chemical attack.

The 40-page booklet contains the records of solved lubrication problems — some might solve your own. Fill in the coupon below, attach it to your letterhead and send it off today.

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The lubricant for extreme conditions

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Please send me your Free Booklet on *Moly-sulfide*
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MOLY

MD-6 MS-6A

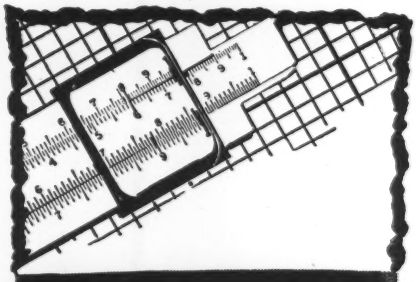
MEN
OF MACHINES

Hammel - Dahl Co., Providence, R. I., recently promoted **John R. Curran** to director of engineering. Mr. Curran received his B.S. degree in mechanical engineering from Northeastern University and, after several years of experience in marine power plant operation and automatic control valve design, joined Hammel-Dahl in 1945 as design engineer. He has served as chief design engineer for the last four years.

John R. Curran

Formerly chief engineer of Standard Pressed Steel Co., Jenkintown, Pa., **Edward H. Wheeler** has been named manager of the Forging Div. **John M. Sherman,** who was previously manager of quality control, succeeds Mr. Wheeler as chief engineer.

The Research and Development Center of Babcock & Wilcox Co., Alliance, O., has appointed **P. R. Grossman** to the position of chief research engineer. Mr. Grossman will be responsible for all work undertaken by the products, materials



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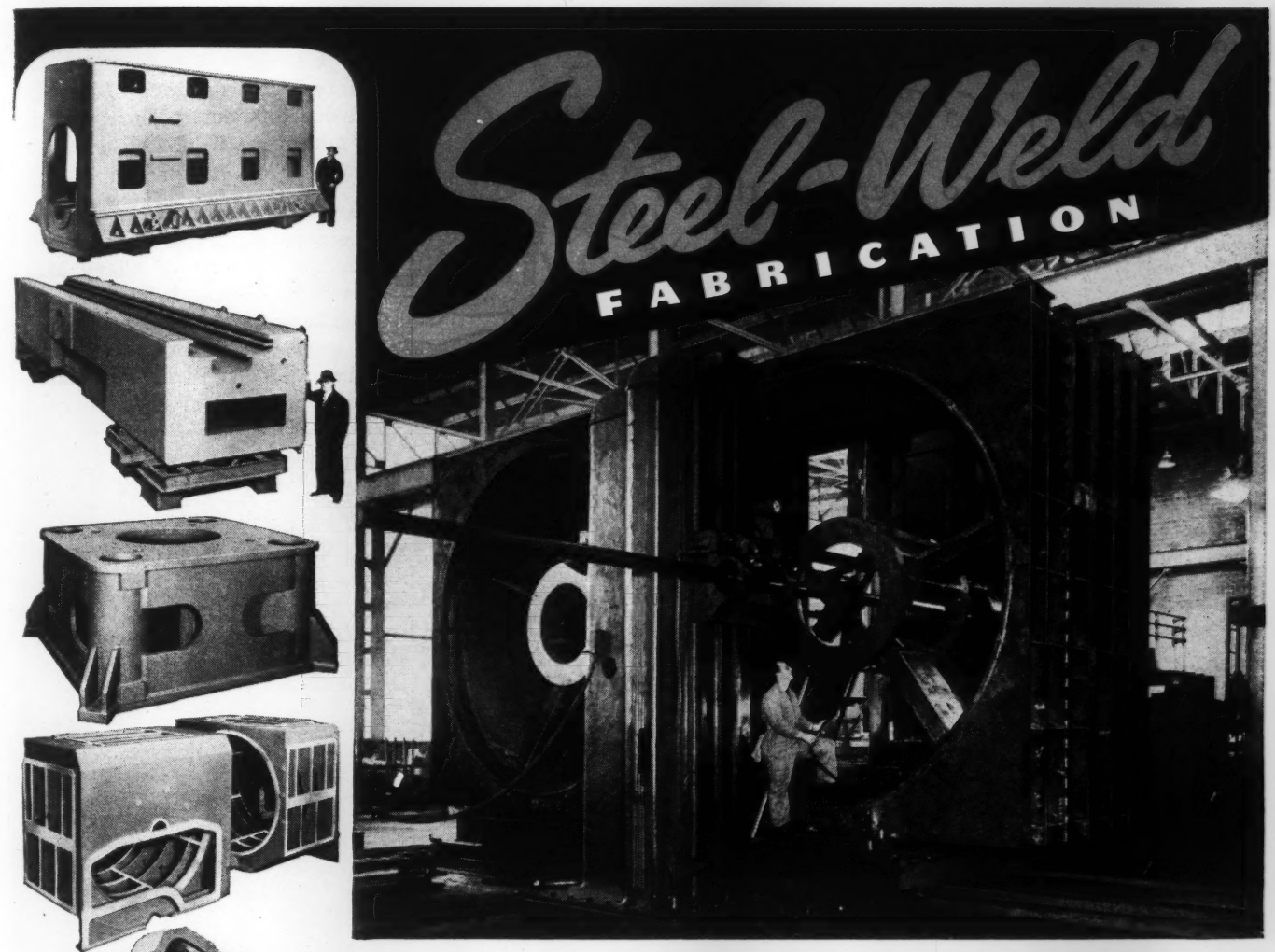

Use WELDED STEEL for Greater Strength with Less Weight!

The two Steel-Weld Fabricated propeller and engine mount sections for wind tunnels, illustrated above, and the parts and assemblies shown at the left, are typical of thousands of Steel-Weld Fabricated units produced and machined by Mahon for hundreds of manufacturers of processing machinery, machine tools, and other types of heavy mechanical equipment. Perhaps you, too, should discuss this service with a Mahon engineer? If you require parts or assemblies including large, heavy pieces, where time and pattern costs are a consideration, Steel-Weld Fabrication may be the answer. You can turn to Mahon with confidence . . . personnel and facilities are available within the Mahon plant to do the complete job from drawing board to finished machining. You will find in the Mahon organization a unique source with complete ultramodern fabricating, machining and handling facilities to cope with any type of work regardless of size or weight . . . a source where skillful designing and advanced fabricating technique are supplemented by craftsmanship which assures a smoother, finer appearing job embodying every advantage of Steel-Weld Fabrication. See Mahon's Insert in Sweet's Product Design File, or have a Mahon engineer call and give you complete information.

THE R. C. MAHON COMPANY
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Engineers and Fabricators of Steel in Any Form for Any Purpose

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To everyone this is
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And to smart gear users
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of *good* gears.

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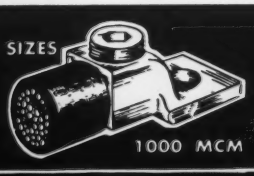

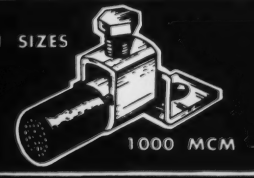

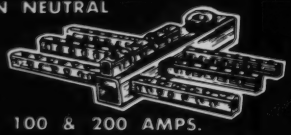

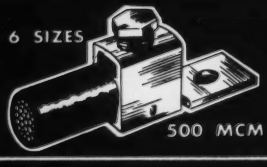

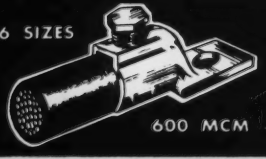

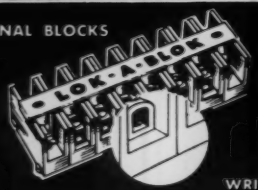

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and technical sections of research and development, both at the center and in the field.

Kenneth F. Oldenburg has been appointed supervisor of the electronic laboratory of Clary Multiplier Corp., San Gabriel, Calif. Mr. Oldenburg joined the company as an engineering designer in 1947 and for the last two years has been a supervisor in charge of the development of new electro-mechanical equipment.

National Pneumatic Co. Inc. and Holtzer-Cabot Divisions, Boston, have appointed **Harvey J. Finison** director of engineering. Mr. Finison was formerly associated with

Harvey J. Finison

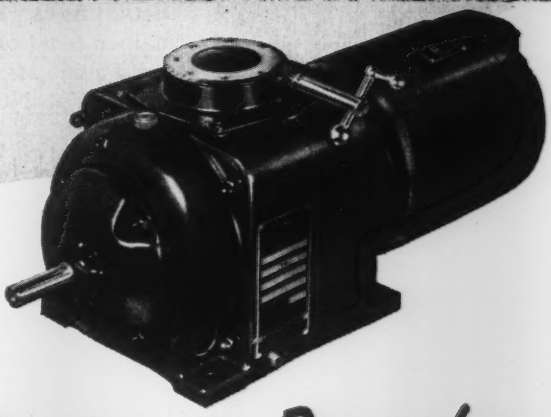
the Armour Research Foundation as an executive in research and development. He has had broad experience in the application and development engineering field.

A member of the engineering department of Lovejoy Tool Co. Inc., Springfield, Vt., since 1941, **Glenn D. Easton** has been appointed chief engineer of the company.

Formerly chief engineer of the Hydraulic Div., **Carl L. Sadler** has been promoted to manager of the new Aviation Div. of Sundstrand

If yours is to be a Superior machine...

It deserves *the best* variable speed drive



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the variable speed drive you can Depend on!

COMPACTNESS. Only the Graham is built as a straight-line extension of a standard induction motor (or available without motor) — the ultimate in simplicity and compactness.

UNLIMITED SPEED RANGE. Only the Graham gives unlimited speed range from any desired maximum speed to zero, plus reverse if wanted, without stopping the motor.

BUILT-IN GEARBOXES. The Graham may be had with built-in reduction or step-up gearboxes — single reduction or double reduction spur or single reduction worm, thus saving the cost and complication of separate gear units.

UNMATCHED FOR ACCURACY. The Graham is unmatched for accuracy of speed setting and resetting and speed holding. The Graham may be held at the same setting for *continuous* operation — 24 hours a day for months or years, without alteration in speed, or its speed may be changed continuously on jobs requiring cyclic speed change. On the tough jobs requiring the ultimate in accuracy the Graham gets the bid.

NO PERISHABLE PARTS. The Graham has no perishable parts such as belts or tubes requiring periodic replacement. It is an all-metal, self-lubricated unit, built like the highest type speed reducer.

A PERFORMANCE RECORD. The Graham has a performance record of over fifteen years' satisfactory use as standard equipment by leading makers of machines (OEM buyers) such as conveyors, feeders, white printers, pumps, welding positioners, machine tool feeds, testing machines, integrators, printing machines, etc., etc.

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most reliable variable speed drive made

Because engineered and rated for continuous round the clock service

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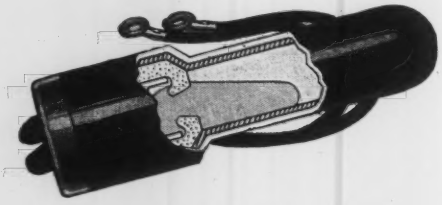

Durakool pressurized all-steel **mercury tilt switches** have more than made good on what may have seemed like extravagant claims a few years ago. The list of Durakool successes grows each year. Seven sizes, 1 to 65 amperes. 3 to 4 weeks delivery. Your production schedule is met.

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50 St. Clair Ave., W., Toronto

Durakool
ALL-STEEL MERCURY SWITCHES

Men of Machines

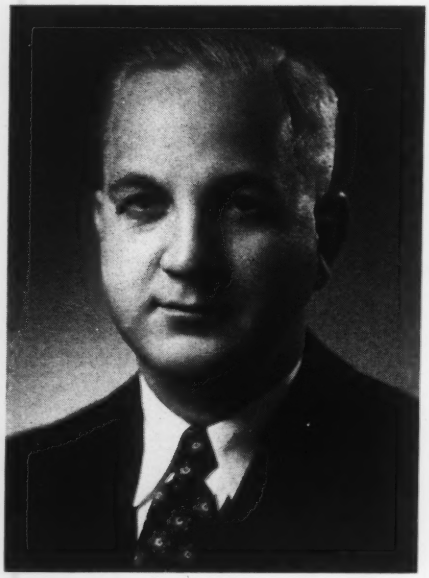
Machine Tool Co., Rockford, Ill. Mr. Sadler joined the organization six years ago as assistant chief of product engineering and was named chief engineer in 1950.

Recent appointments made by Peerless Electric Co., Warren, O., include those of **Cecil G. Young** as chief engineer and **J. L. Hadley** as vice president and technical counsel. Mr. Hadley was formerly vice president in charge of engineering.

To be in charge of final design of the company's commercial products, **Sava Jacobson** has been named head of product engineering for Pacific Mercury Television Mfg. Corp., Van Nuys, Calif.

Nash-Kelvinator Corp., Detroit, has appointed **Lawrence A. Philipp** vice president of appliance engineering and research and **William Mikulas** chief engineer. Formerly vice president in charge of Kelvinator engineering, Dr. Philipp will head long-range product development and research and will also act as consultant on appliance engineering. He joined the company as director of Kelvinator research in 1927, after completing postgraduate studies at the University of Michigan. He was named manager of Kelvinator's Detroit plant in 1937, chief engineer of the Kel-

Lawrence A. Philipp



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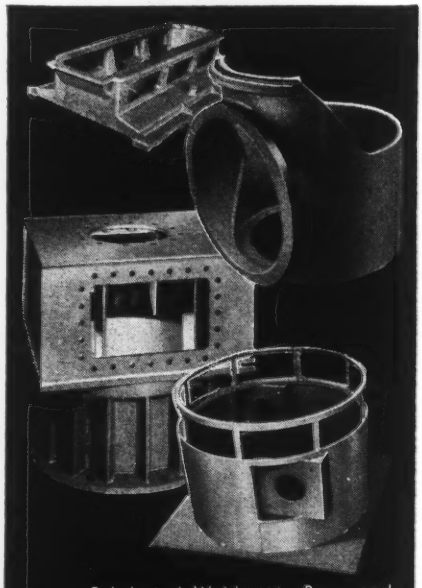

Fabricated Weldments, Bases and Sub-Assemblies are demanded by industry today because they insure accuracy, economy and modern design. They provide strength that withstands shock, strain, vibration, reduces machining and weight.

Littleford Fabricated Weldments, Bases and Sub-Assemblies are backed by years of experience in shearing, bending, forming, welding and finishing plate and sheet metals. Littleford has never lost sight of the fact that accuracy and quality are essential to the finished product. If you have a problem involving Fabricated Weldments, Bases or Sub-Assemblies, send blueprints to Littleford and see how experience can give low-cost quality products.

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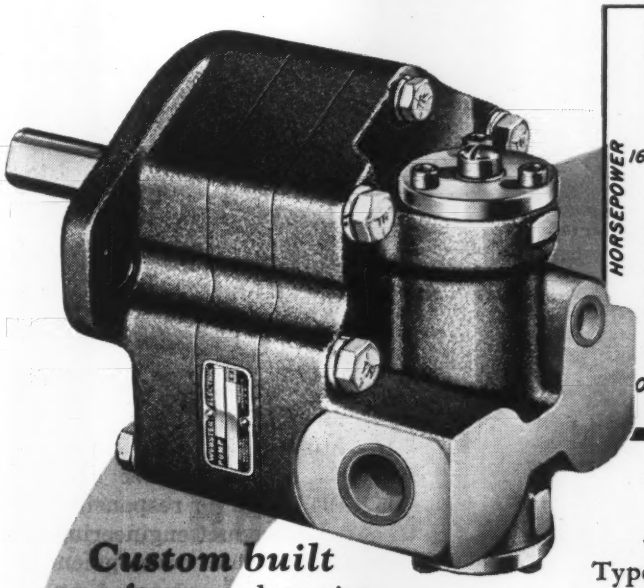
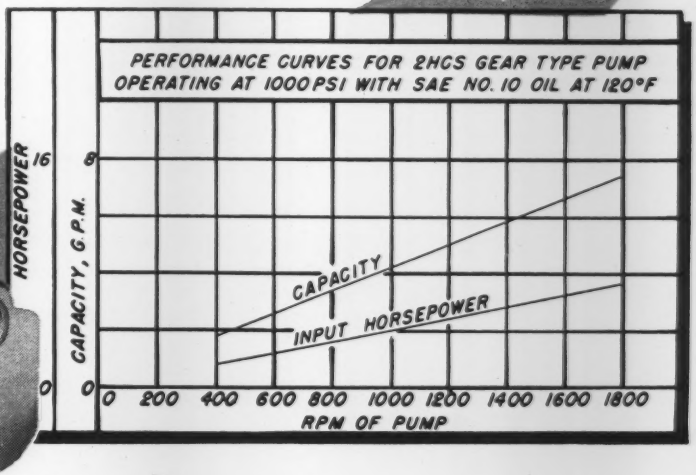
Check this typical WEBSTER Hydraulic Pump Performance Curve





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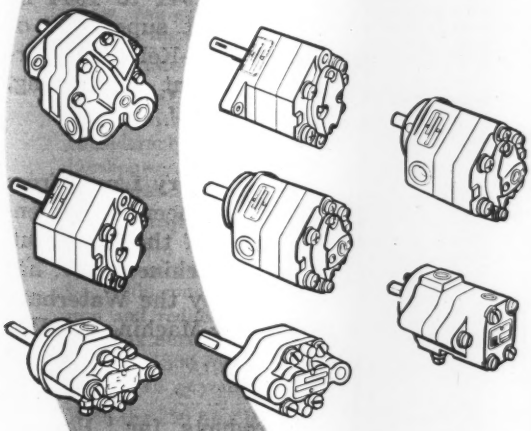
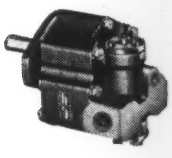


• It will pay you to get the facts about WEBSTER Gear-Type Hydraulic Pumps before buying any pump. Here is a complete line of rugged, dependable pumps from 10 gph. to 10 gpm., engineered to operate efficiently at pressures up to 1200 psi. at speeds of 3600 rpm. or less—90 types of WEBSTER Oil Hydraulic Pumps of various designs and capacities to meet the widest range of requirements!

• WEBSTER pumps are the product of skill acquired during nearly a quarter-century of experience. They have established an enviable reputation for efficient, dependable operation. All WEBSTER pumps lend themselves readily to many forms of adaptation—and to modification for special installations. All are available with built-in relief valve, if desired.

• Whenever you require pumps for lubricating, oil circulating, filtering, transfer or quiet hydraulic power applications, we invite your inquiries.

Write *today for catalog containing performance charts and pump data sheets on which you can describe your requirements*



OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

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An interesting challenge for senior design engineers to work directly with top project supervisors helping through the prototype stage new developments in:

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For these jobs we are interested in men with two or more years experience in electro-mechanical work related to the above fields or in men with superior scholastic records in physics; electrical, electronic or mechanical engineering.

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Our policy of permanency of positions and continuity of service does not allow us to employ engineers unless there is a *clear and definite need for them projected years into the future.* And we promote from within.
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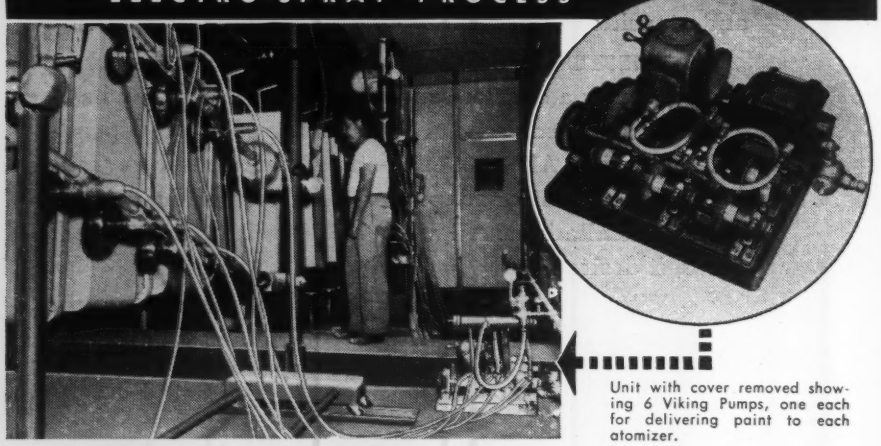
FOR EXACTING RANSBURG ELECTRO-SPRAY PROCESS



Unit with cover removed showing 6 Viking Pumps, one each for delivering paint to each atomizer.

The Problem: In order to spray paint electrically charged particles without over-spray, the Ransburg Process demands accurate fluid delivery over very long periods of continucus pumping.

The Answer: Viking Pumps were designed to meet Ransburg's requirements of very accurate and smooth delivery at varying and extremely slow speeds.

Have you an exacting pumping job? Then send for free bulletin 1803H.

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CEDAR FALLS, IOWA

Men of Machines

William Mikulas

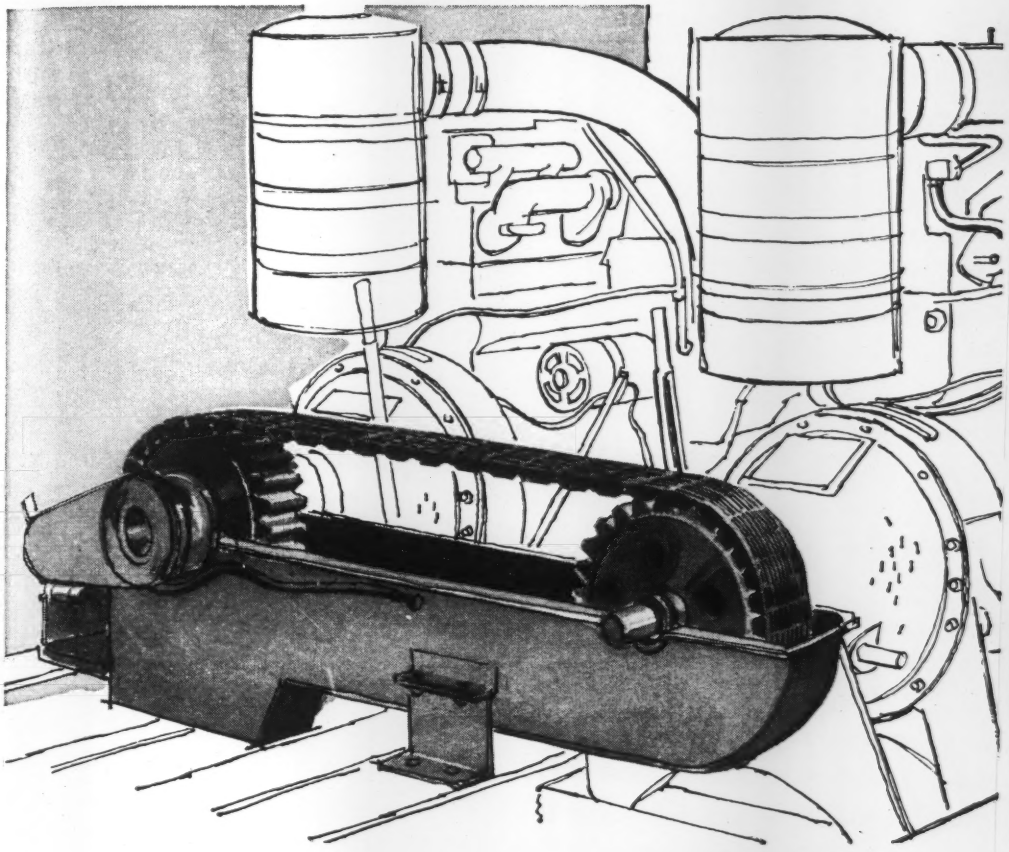
vinator Div. in 1939, and vice president in 1946.

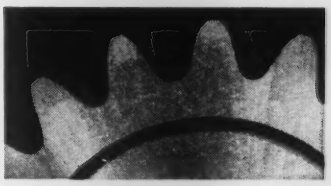
Dr. Mikulas, who has been Kelvinator's assistant chief engineer since 1949, now is responsible for all current product engineering and immediate product development engineering. Also educated at the University of Michigan, he joined the company in 1936 as chief metallurgist. From 1941 to 1944 he served as assistant supervisor of quality at the Nash-Kelvinator aircraft propeller plant in Lansing, Mich.

Promotion of **Harry Lange** from assistant chief engineer to chief engineer in charge of the Bolt, Nut, Screw & Rivet Machinery Div. has been announced by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

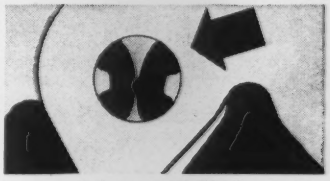
Airway Products Inc., Pontiac Mich., has announced the appointment of **McKellar Graham** to the post of chief designer. For the last 14 years Mr. Graham has been associated with Vickers Inc. as a project engineer.

John L. Ditzler has been named to fill the post of engineering manager for the new Air Conditioning Div. of Westinghouse Electric Corp. at Staunton, Va. Mr. Ditzler joined the company as a graduate student





Hy-Vo's many design and manufacturing refinements result in a drive with unusual power transmitting capacity. Note involute tooth design of Hy-Vo Sprockets . . .



. . . and the new, Hy-Vo Compensating Rolling Joint, which always shifts the pitch line automatically as the Hy-Vo Chain engages the involute teeth of the sprocket.

Chain follows a path truly tangent to sprocket pitch circle, virtually eliminating chordal action. A new, balanced link design greatly improves stress distribution.

How compounding with HY-VO could save you as much as $4,560

Now, you gain new advantages in buying and compounding smaller, higher speed engines with Morse Hy-Vo Drive.

You make major cost savings.

The total cost of two high-speed engines and the Hy-Vo Drives with which they are compounded, will usually be considerably less than a single large engine of equivalent horsepower. A brief look at some figures will show how this works . . .

For example, if you needed 250 continuous horsepower at 1200 rpm., you could: 1) Buy a manufacturer's 250 hp., 1200 rpm. engine, which lists for $13,380; 2) buy the 250 hp., 1800 rpm. engine for $11,930 (using Hy-Vo as a connection and reduction drive, also eliminates the costly flexible coupling normally required in choice No. 1); 3) or, use two 130 hp., 1800 rpm. engines, listing for a total of $8,820, and use Hy-Vo as your compounding drive.

With the 250 hp., 1800 rpm. engine, you save $1,450—more than enough to pay for your Hy-Vo Drive. Compounding two 130 hp., 1800 rpm. engines, you save $4,560 over base list cost of the 250 hp., 1200 rpm. engine.

From this saving you could pay for your Hy-Vo Drive and bank several thousand dollars. In most cases, too, Hy-Vo will be so narrow it will eliminate costs of outboard bearings and mountings, with the bonus that single-engine operation is possible under reduced power requirement.

Other power transmission methods generally have either inherent restrictions on rotative speeds and velocities that limit 200 hp. or larger engines to 1200 rpm., or are too costly. Hy-Vo has far greater upper limits, with relatively lower cost.

Because of exceptional rotative speeds and velocities, Hy-Vo brings you comparable savings in electric motors, too. Write us for details on compounding with Morse Hy-Vo Drive.

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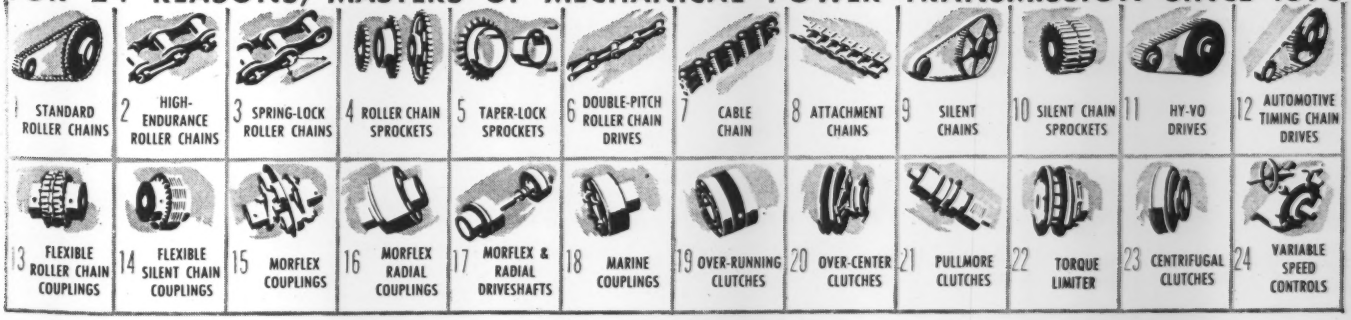

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- Costs less per H.P.
- Has fixed or adjustable centers for horizontal or vertical shafts
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- Fits present motors
- Engineered for smooth, quiet, trouble-free power transmission
- Built to Lewellen quality standards
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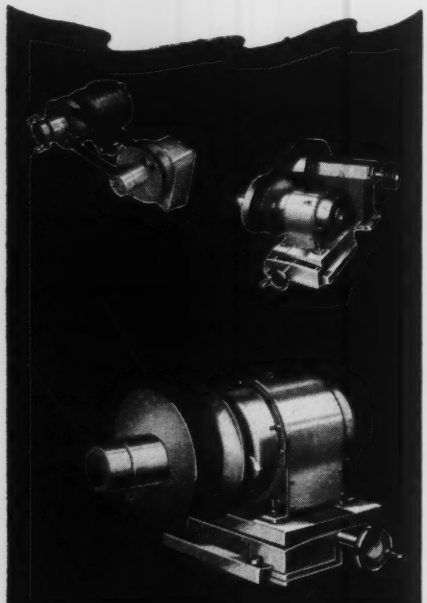
- Up to 4 to 1 speed range with single variable pulley
- Up to 10 to 1 speed range with combination pulleys



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Service in variable-speed control exclusively for more than 50 years. May we help you?

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Men of Machines

trainee in 1933 and served as a design engineer from 1935 until 1943, when he was made a section engineer. In 1945 he was named engineering manager for the air conditioning engineering department of the Sturtevant Div.

Walter E. Schroeder

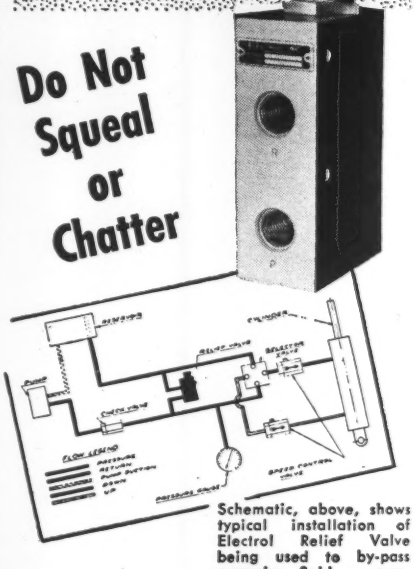
Walter E. Schroeder has been appointed chief engineer of the Colonial Iron Works Co., Cleveland. Mr. Schroeder attended Carnegie Institute of Technology and Schwab Engineering School. He was formerly associated with the Mesta Machine Co., Westinghouse Electric Corp. and the Sharon Works of General American Transportation Co. Most recently, he held the position of district chief in charge of all Canadian activities of the Stone & Webster Engineering Corp. at Toronto and Boston. In his new position, Mr. Schroeder will be associated with **Dr. Donald Q. Kern,** director of engineering.

Warren C. Hutchins has been named manager of product planning for the Meter and Instrument department of General Electric Co., Lynn, Mass.

Consolidated Vultee Aircraft Corp., San Diego, Calif., has advanced **R. R. Hoover,** former project engineer, to chief project engineer and **W. S. Ivans Jr.,** former

Electrol Relief Valves

Do Not Squeal or Chatter



Schematic, above, shows typical installation of Electrol Relief Valve being used to by-pass excessive fluid pressure.

Dampening Device Assures Quiet . . . Efficient Performance

Designed for use in oil pressure systems, Electrol Relief Valves are equipped with an Electrol-designed dampening device that smothers squeal or chatter. They have a cracking pressure up to 90% of the full flow, with a reseating pressure that can be held as high as 85% of the full flow.

The Model #523-8 measures 1 3/8" x 2" x 5", has ports tapped 3/8"—18 N.P.T., and passes 6 G.P.M.; **the Model #523-14** measures 2 3/8" x 3" x 8 1/4", has 3/4"—14 N.P.T. ports and passes 16 G.P.M. Both units have a pressure range of 100 to 2,100 P. S. I. Your inquiry will receive prompt attention.

Better Designed Products Use Electrol Hydraulics

Electrol HYDRAULICS

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CHECK VALVES • RELIEF VALVES • HAND PUMPS
POWERPAKS • LANDING GEAR OLEOS • SOLENOID VALVES • ON-OFF VALVES • SERVO CYLINDERS • TRANSFER VALVES • CUT-OUT VALVES • SPEED CONTROL VALVES

APPLETON

"ST" Series CONNECTORS*

for

Liquid Tight Flexible Conduit

("Sealtite" or Equivalent Products)

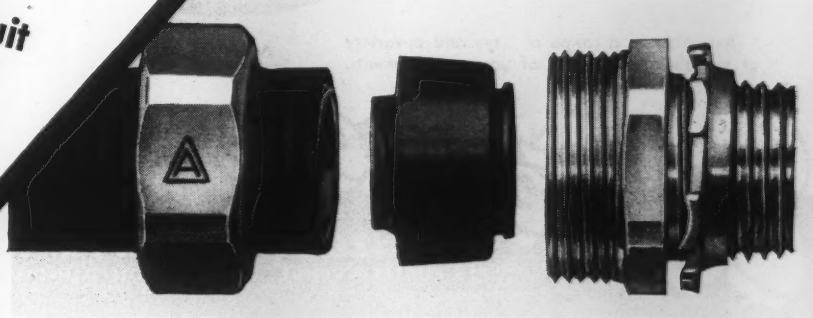
*Patent Applied For

UNIQUE

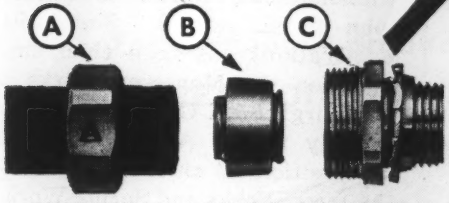
Patented Construction

No Other Liquid Tight Flexible Conduit Connectors Have The APPLETON Brass Ferrule. Ferrule Screws In and Crimps On For a Perfect Seal and Positive Ground

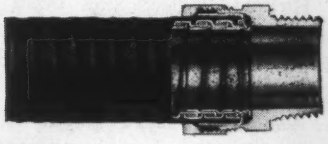
. . . Always!



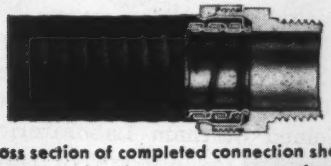
HERE'S HOW THEY WORK:



Slide nut (A) over conduit. Screw ferrule and sleeve assembly (B) into conduit. Tighten nut onto connector body (C).



Completely assembled "ST" connection. (IMPORTANT: nut must be tightened as far as possible to complete compression action which assures liquid-tight seal.)



Cross section of completed connection shows how tapered end of nut compresses ferrule wall . . . seals perfectly and gives positive ground between conduit and connector.

The Only Fittings of their Kind . . . Provide *Positive* Wiring System Protection

Here are flexible conduit connectors with a big plus! Nothing to come loose, deteriorate, crack or break! Patented ferrule *Appleton* "ST" Series Connectors stay tight to assure positive exclusion of liquids, fumes, chips, shavings and other foreign matter from machinery electrical systems. And since the threaded, brass ferrule is crimped on, there is a *permanent* ground between conduit and connectors that maintains voltage unfailingly within 10 millivolts drop.

Appleton "ST" Series Connectors come straight to fit flexible conduit from ⅜" to 4". Also, 45° and 90° to fit flexible conduit from ⅜" to 2". To avoid costly shutdowns and loss of man hours, due to wiring system failure, *write for full information.*

A QUALITY LINE OF ELECTRICAL FITTINGS ALL FROM ONE SOURCE SOLD THROUGH ELECTRICAL WHOLESALERS ONLY

APPLETON ELECTRIC COMPANY

1721 Wellington Avenue • Chicago 13, Illinois

Also Manufacturers of

Explosion-Proof Fixtures

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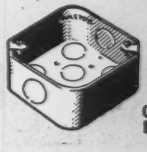
Outlet Boxes

It has to be good....

When it can't be readily serviced—that's another WATERMAN FLOW REGULATOR STORY.

Yale & Towne install WATERMAN FLOW REGULATORS inside the lift cylinders on all their fork trucks. Only products rendering years of trouble-free service are installed where they would not be readily accessible for servicing.

WATERMAN FLOW REGULATORS can give you years of trouble-free automatic flow regulation and at the same time reduce weight, space and cost while simplifying your hydraulic circuits.

Available in a range of sizes and a variety of models to take care of your requirements.

A 6,000 lb. Yale Gas Fork-Lift truck in operation.

Write for our illustrated brochure F

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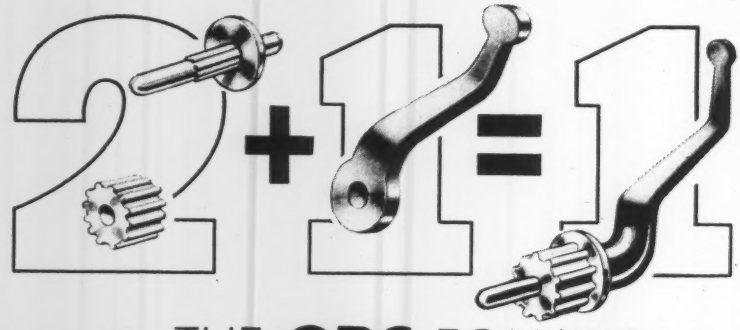

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FOR MAKING YOUR SMALL
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Add parts and operations and you add cost . . . GRC reduces operations, makes small parts in ONE low-cost die casting. Gries methods speed production, prevent waste, offer design improvement. If you use small parts, chances are that Gries engineers can show you how to simplify—and save. Fast delivery of 100,000 completely finished small parts — to many millions. *Write today for bulletin and samples.* Send prints for prompt estimates.

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Max. Wt. ½ oz.
Max. Lgth. 1¾"

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32 Second St., New Rochelle, N. Y.
Phone: NEw Rochelle 3-8600

Men of Machines

chief electronics design engineer, to chief electronics engineer. Mr. Hoover joined the company in 1936, and Mr. Ivans has been associated with Convair since 1946.

H. J. Kalberkamp was recently appointed chief engineer of Mesta Machine Co., Pittsburgh, Pa. He has been associated with the company for 28 years.

Toledo Scale Co., Toledo, O., has named **Donald B. Kendall** assistant to the director of engineering.

Harvard K. Hecker has been elected vice president in charge of engineering of Curtis Mfg. Co., St. Louis, Mo.

Crucible Steel Co. of America, Pittsburgh, has appointed **James K. Watkins** chief engineer of its Midland, Pa., works to succeed **John Ferm,** retired. Since 1944 Mr. Watkins has been chief engineer for the Monessen works of Pittsburgh Steel Co. Crucible also recently named **A. T. Forrest** to the position of chief engineer for the Park Works and Spring Works.

Rubert Capley has been named chief engineer of the steel and tube division of Timken Roller Bearing Co., Canton, O., succeeding **Walter J. Assel,** who has retired. Mr. Capley is replaced as assistant chief engineer of the division by **James T. Cook.**

Former chairman of the Physics Department of the University of Texas, **Dr. S. Leroy Brown** has joined Statham Laboratories, Los Angeles, as director of research.

D. C. R. Miller has been named general manager of Dow Corning Silicones Ltd., the recently organized subsidiary of Dow Corning Corp., located at Wilson Heights, Toronto, Canada.

Formerly staff assistant to the vice president in charge of research

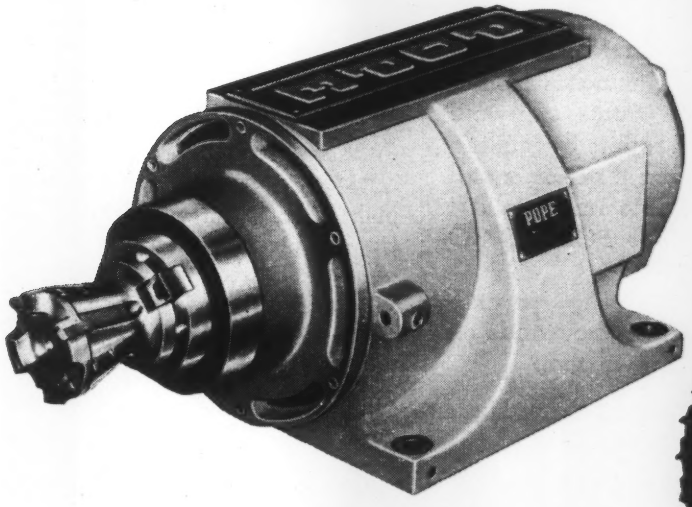
You Can *Specify*

POPE HEAVY DUTY WHEEL HEAD SPINDLES

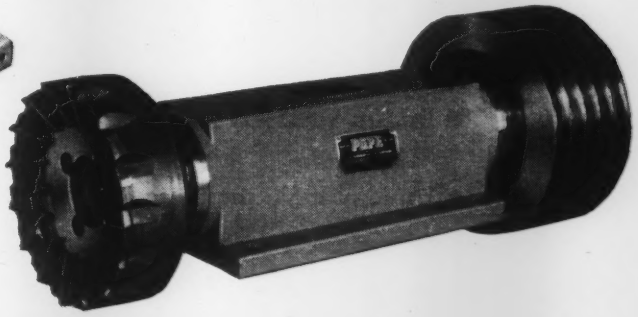
With Confidence

POPE Spindles like these are designed for a wide variety of applications including grinding, boring, milling, drilling and many other operations requiring PRECISION COMBINED WITH RUGGEDNESS.

For continuous production and trouble-free operation
THERE'S NOTHING LIKE A POPE SPINDLE WITH ROLLER BEARINGS



◄ **P-2565 Heavy Duty, Totally Enclosed, Fan Cooled, Motorized Milling Spindle in sizes from 1 to 30 HP, 600 to 3600 RPM, 220-440 or 550 volts, 3 phase, 60 cycle (other electrical specifications available.)**



P-12007 Heavy Duty Belt Driven Milling ► Spindle, in sizes from 1 to 50 HP.

SEND US YOUR SPECIFICATIONS AND LET OUR ENGINEERS RECOMMEND THE SPINDLE FOR THE JOB YOU ARE GOING TO DO **No. 99**

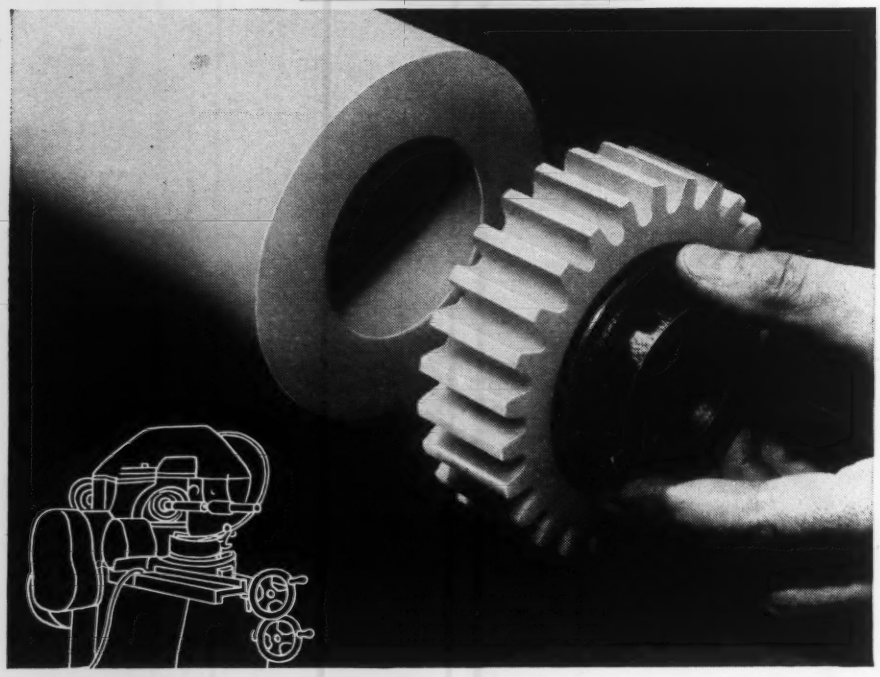
Specify **POPE** **PRECISION SPINDLES**

POPE MACHINERY CORPORATION

Established 1920

261 RIVER STREET ... HAVERHILL, MASSACHUSETTS

POLYPENCO® NYLON SHAPES



NOW! Get Nylon's Performance in Gears, Bearings . . . at Lower Cost

• POLYPENCO tubular bars now enable you to get nylon's advantages in gears, sleeve bearings, bushings, packings, and other large parts with big cost savings. Machining practically eliminates tooling cost, and this thick-walled stock assures minimum waste of nylon. Further savings can be obtained in nylon gears and rollers by making the outer sections from this stock and then combining them on metal inserts. POLYPENCO tubular bars are now available in 2" to 10" O.D.'s with ⅜" to 1½" walls. With this and other POLYPENCO shapes, you always get these advantages:

- Economical fabrication of one part or thousands on standard metalworking tools in your own shop
- Design flexibility . . . closer tolerances in many kinds of parts
- Uniform high quality in every piece
- Immediate delivery of most standard sizes
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POLYPENCO® NYLON
... teflon* and other non-metallics

Warehouse stocks: Reading • Chicago • Los Angeles • Newton (Mass.) • Branford (Conn.)

*trademark for DuPont tetrafluoroethylene resin

Men of Machines

and engineering, **James R. Ireland** has been appointed assistant director of research by Indiana Steel Products Co., Valparaiso, Ind.

Having served as assistant chief of the Office of Basic Instrumentation at the National Bureau of Standards, **Edward C. Lloyd** has been appointed chief of the Mechanical Instruments Section. He succeeds **Dr. W. G. Brombacher**, who has retired.

Frank A. Ayer, copper mining consultant, and **Walter H. Sammis,** president of Ohio Edison Co., have been named 1954 recipients of the Egleston Medal, Columbia University's highest award "for distinguished engineering achievement."

Vincent Prus, associated since 1952 with the Goodyear Aircraft Corp. of Akron, O., has been placed in charge of the company's rocket production program.

Double A Products Co., Manchester, Mich., has announced the appointment of **Charles E. Finn** as assistant to the vice president in charge of the Hydraulic Div.

John G. Fleming has been appointed to the newly created position of product planning manager of the Bristol Co., Waterbury, Conn.

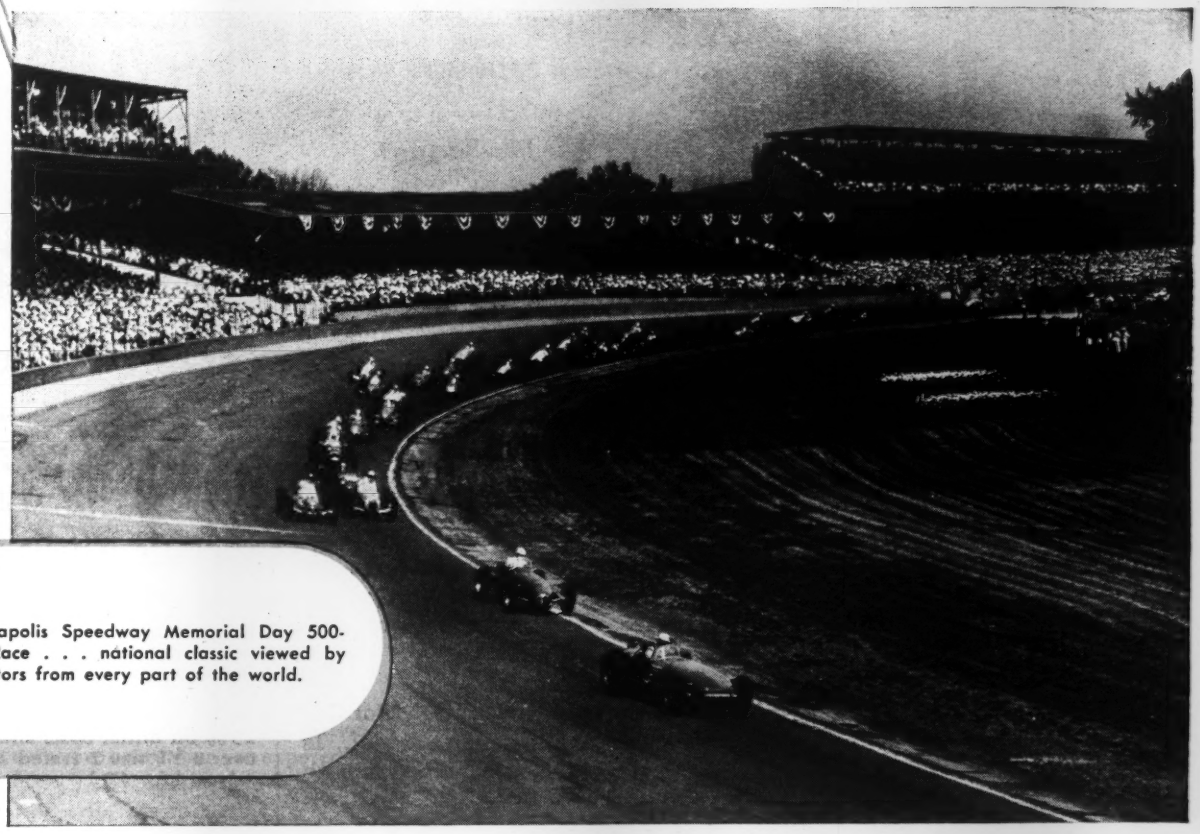
KSM Products Inc., Merchantville, N. J., has named **H. L. Wagener** special consultant to its technical research group to guide in developing new materials and processes in stud welding.

Associated with the company for 19 years, **Roy W. Daub** has been named chief planning engineer by Lebanon Steel Foundry, Lebanon, Pa.

Edward L. Hart has joined Servel Inc., Evansville, Ind., as manager of civilian quality control. For the last 15 years Mr. Hart has been associated with the Philco Corp.

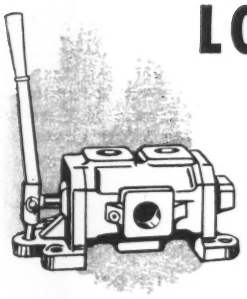
LOGAN . . . a national participant in major fluid power advancements

SINCE 1916



Indianapolis Speedway Memorial Day 500-Mile Race . . . national classic viewed by spectators from every part of the world.

LOGAN HYDRAULIC CONTROL VALVES



Illustrated, Model 4095—4-way, 2-position valve for directing pressure alternately to ends of double-acting hydraulic cylinder.

A broad range of types and sizes to most effectively meet any requirement—Design Engineers, Machine Operators, Maintenance Men appreciate these Logan advantages

- LONG-LIFE CONSTRUCTION
- EASY TO SERVICE
- INFREQUENT MAINTENANCE
- EASE OF INSTALLATION
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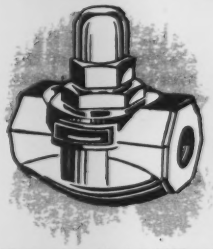
- UNRESTRICTED PORTING

Let Logan Engineers help you design your Air and Hydraulic Circuits



Illustrated, Model 8015 adjustable speed control valve. Install between operating valve and one end of cylinder to meter flow of oil in one direction with free flow on return.

LOGAN MANUFACTURES 6,975 STANDARD CATALOGED ITEMS

FREE CATALOG ON REQUEST

AIR CONTROL VALVES, Cat. 100-4 • AIR CHUCKS, Cat. 70-1 • AIR CYLINDERS, Cat. 100-1 • AIR-DRAULIC CYLINDERS, Cat. 100-3
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SAVES TIME — Logan — AIR AND HYDRAULIC EQUIPMENT — EFFORT-MOTION

LOGANSPORT MACHINE CO., INC., 811 CENTER AVE., LOGANSPORT, IND.

Give your appliances this EXTRA VALUE ...at NO extra cost!

MARK-TIME two-speed BELL TIMER

Normally supplied with Center Stud mounting.

The exclusive, patented 2-speed feature of this Mark-Time unit makes it TWO timers in one! . . . and puts more "sell" into your appliances!

Here's why: in the long-time position, the user can measure time up to ONE HOUR for baking, roasting, stewing and other lengthy cooking operations . . . can use it as a reminder for appointments and other household jobs, too! By moving the lever to the short-time position, the user can obtain settings within seconds for boiling eggs, pressure cooking . . . precise timing for all short time jobs up to SIX MINUTES, where even fractions of a minute are important.

At the end of the pre-set time period, in either long or short range, this timer gives a clear, resonant bell signal.

Available with a wide variety of modern dials and knobs, also in 2-hour, 12-minute range.

Write today for full details and prices.

MARK-TIME

M. H. RHODES, INC.
HARTFORD, CONNECTICUT

Manufactured and sold in Canada by
SPERRY GYROSCOPE OTTAWA, Limited
3 Hamilton St., Ottawa, Ontario, Canada

Stress Relief

HOW TO BE successful the easy way might be the superficial appraisal of J. P. Henderson's subject:

The Idle Boss

Do you work in an office where the boss apparently has all the time in the world? Do you catch him idly pacing up and down or looking out of the window?

There are probably two explanations for this and the simplest one is that he is lazy. Is your organization a mess? Are things not looked after which require supervisory action? If that is the case and the boss is idle, then he *is* lazy.

Perhaps you are fortunate. If he's too obviously so, he may have to be replaced and a hardworking young fellow like yourself might get the job. Maybe!

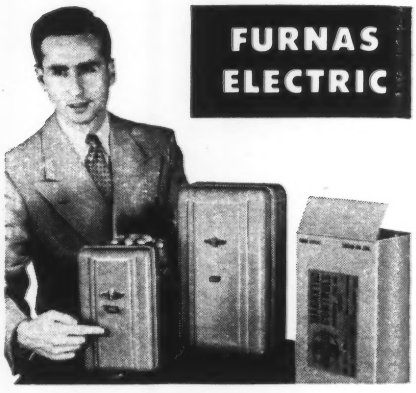
The other explanation for an idle boss requires more detail. Is your organization a pretty smooth running one (within the limits of human frailties)? Do you all know what to do about your routine work and does it all handle itself fairly automatically? Do you have your own responsibilities and a pretty good idea as to just how far they extend?

Now if the boss is idle in that kind of an organization he deserves to be. He's developed an *organization* in its truest sense and he's letting it run.

Suppose you were given the job of designing some mechanical or electrical gadget and it is built. It operates satisfactorily except that major items are constantly getting out of order. It works, but it requires almost constant attention and major overhauls. Would you be proud of it? Wouldn't it be better if it operated with the minimum of attention and only normal service?

Well, your boss was once called

FURNAS ELECTRIC



Why Pay FOR STARTER CAPACITY NEVER USED?

THE ANSWER TO THIS QUESTION COULD SAVE hard-earned dollars needlessly thrown away.

When choosing from the widest range of starters in the 1-50 hp range, you save by selecting the starter matched to the job—with no wasted capacity.

Furnas Electric starters—nine of them in the 1-50 hp range—are designed and built to match most applications.

Save 25% TODAY LIKE THIS

Here's an example of typical savings you can earn through proper starter selection: for 10 hp service, for example, you'd select Furnas Electric Type YE rated for the job. This saves you up to 25% on initial costs and 40% on space over a YF size 2 (rated 25 hp) normally selected for 10 hp service.

All of the nine Furnas Electric sizes offer worthwhile savings.

Important FEATURES

Furnas Electric starters give you these additional benefits. *Dual Voltage Coils*—matched to motor voltage. *Thermal Overload Protection. Shallow Case* for easy wiring. *Durability* to stand up under rough service. *Arc Resistant Terminal Board. Arc Quenching Silver Contacts.*

Complete RANGE OF OTHER PRODUCTS

Pressure switches for air and water applications. Drum controllers for reversing, multi-speed and reversing multi-speed service.

Write today for *full story* or contact our representative near you. Furnas Electric Co., 1045 McKee St., Batavia., Illinois.

FURNAS ELECTRIC
Batavia, Illinois

Can you use these new self-locking Nuts?

Designed for special applications . . . Do they suggest solutions to *your* design problems?

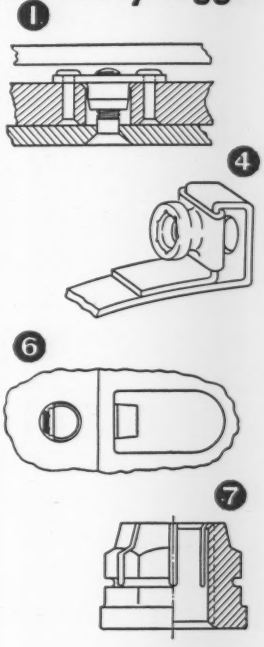
1 TWO-LUG INVERTED ANCHOR NUT For use where clearance or other considerations make it necessary to mount the nut upside down. Clearance hole must be provided for the barrel. Nylon inserts.

2 LIGHT HEX NUT, KEL-F INSERT Special KEL-F insert provides the self-locking, vibration-proof features of all ELASTIC STOP® nuts, for operation under extremely corrosive conditions—or exposed to strong acids—such as fuming nitric.

3 TWO-LUG HIGH-TENSILE ANCHOR NUT For use with 160,000 psi bolts, in blind mounting or in applications where ease of maintenance makes an attached nut desirable. Nylon inserts.

4 SELF-LOCKING CLAMP NUT For installation around the clamp leg, or on slotted strips where a random lengthwise positioning of the nut is necessary. Red nylon locking insert.

5 HIGH-TEMPERATURE, CLOSE CLEARANCE DOUBLE-HEX NUT For applications where weight, wrenching area and elevated temperatures are all major considerations. Temperatures to 1200° F.



6 LIGHTWEIGHT BARREL NUT Barrel nuts permit the use of lighter forgings—and simplify machining. "Bathtub" type recesses are necessary for the bolt head only, since the barrel nut fits into regular drilled hole. Wrenching is simplified because the nut cannot turn. This is a lightweight version of the ESNA high-tensile barrel nut, for 160,000 psi bolts. Nylon inserts.

7 ACCESSORY MOUNTING NUT High-temperature nut for mounting generators or similar accessories having a keyhole-type mounting flange. Large base diameter compensates for seating area lost to slot in flange. Nut straddles slot without Brinnelling the flange. Temperature to 550° F.

8 HIGH-TEMPERATURE FLOATING-BASKET ANCHOR NUT Specially designed for applications where a lesser degree of accuracy in alignment of nut and bolt hole is desirable. To 1200° F.

[redacted] information

ESNA

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. N48-64. Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send details on the following fasteners:

☐ 1 ☐ 3 ☐ 5 ☐ 7
☐ 2 ☐ 4 ☐ 6 ☐ 8

☐ Here is a drawing of our product. What self-locking fastener do you suggest?

Name_____ Title_____

Firm_____

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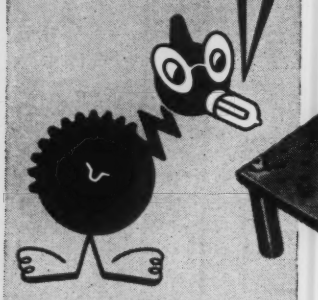
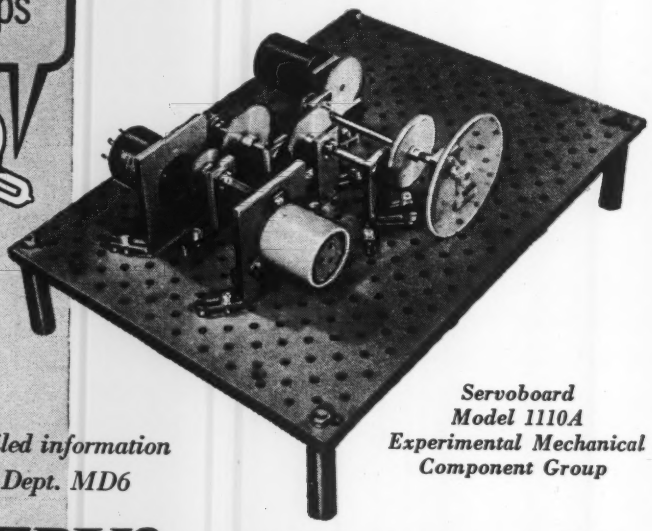
City_____ Zone_____ State_____

Hook Up With Servoboard and Speed Up Your Set-Ups



Whatever you're assembling—servo system, computer or regulator—the Servoboard speeds up the job by providing means for quickly synthesizing the electro-mechanical parts of the control system. Complete set includes gears, shafts, bearings, hangers and mounting plates, all precision made for rapid coupling with necessary motors, tachometers, synchros, potentiometers and amplifiers.



Servoboard Model 1110A Experimental Mechanical Component Group

For detailed information Write Dept. MD6

SERVO CORPORATION OF AMERICA
New Hyde Park, New York

SC 121

INTER-OFFICE MEMORANDUM
TO: FRED JOHNSON – Engineering

Fred—
Will you check with Ahlberg? Understand they make just the bearing for our job #10343 – good bearings, too!
Jim

AHLBERG
BALL BEARINGS
over 1,000 types and sizes

Ahlberg Bearing Company, 3025 W. 47th St., Chicago 32, Ill.
SALES ENGINEERS IN PRINCIPAL CITIES

Stress Relief

upon to design something too. It was an organization instead of a gadget. And if he did a good job, it runs itself without his being bothered every minute by servicing and repairing it.

Do you think *he* should be doing some of the jobs he hands on to you? Maybe so, but perhaps you are luckier than you think. Every time you are given a job that you think the boss should handle you are given the chance to learn a little more about his job—another expression also of the responsibility that he freely hands out. The alternative is worse—with less chance for your own personal development.

One of the hardest lessons for a new supervisor or department head to learn is this fact: *He must apparently make himself dispensable.* It's the exact opposite from the attitude of the ambitious young employee who has tried to work up the ladder and gain some legitimate security by making himself indispensable.

Once promoted to an executive job, he must do the old switcheroo. Ideally he organizes his department so that it runs itself and apparently could get along without him. He organizes it so someone else has all the detail work to do along with certain clearly defined responsibilities. If he's successful that gives him some of that apparent idleness that may bother you.

All along I've mentioned this boss as being *apparently* dispensable, and *apparently* idle. Actually a wise management rewards a man who can do such an organizing job, and considers him necessary. Most department managers are not paid for the detail work they take on and can push out, but for their *decisions.*

—J. P. HENDERSON

They Say...

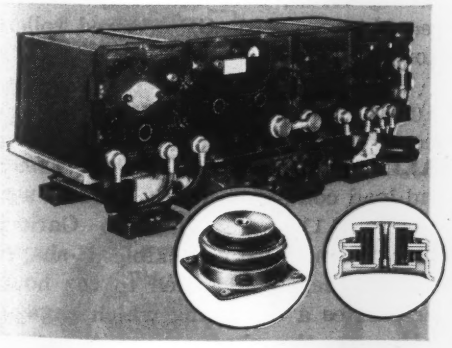
"One of the things we have to be thankful for is that we don't get as much government as we pay for."—CHARLES F. KETTERING

JUST A MATTER OF CONTROL

LORD ENGINEERING CONTROLS VIBRATION ... anywhere!

Your continuing effort to improve your products and reduce their maintenance cost may be entirely A Matter Of Control . . . the control of destructive vibration and shock. To help you to accomplish your objectives, Lord Engineering recommends the correct design, selects the most suitable elastomer and metal, and uses precision manufacturing for all Vibration Control Mountings and Bonded Rubber Parts. Your vibration and shock control problems are our business. We welcome the opportunity of placing our wide experience in many diversified industries at your disposal.

Over 27,000 designs and their variations from which to choose.



The sensitivity of many commercial and military radio transmitters is protected . . . their accuracy is insured against vibration and shock damage by Lord Vibration Control Mountings. Ask for complete details.

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LORD MANUFACTURING COMPANY • ERIE, PA.

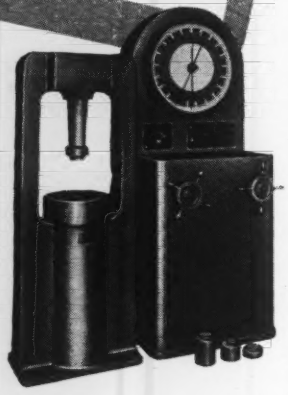
LORD BONDED RUBBER

Headquarters for **VIBRATION CONTROL** FOR 30 YEARS

PALMETTO® G-T® RING

MEANS SIMPLIFIED DESIGN
MEANS LESS MACHINING TIME

ASK BALDWIN!

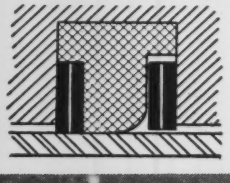


The Baldwin-Lima-Hamilton Corporation, Eddystone, Pa. Division, recognized a manufacturing advantage in the PALMETTO G-T Ring. Designing it into their Baldwin Compression Testing Machine (capacity—50,000 lb; pressure—1,000 psi; stroke—3 in.) meant design simplification—a simple groove instead of a complex stuffing box. Here is where engineering foresight paid off... Changing to this modern dynamic ram seal not only saved space, but hours of machining as well. Because high sealing efficiency and long service life are maintained along with these manufacturing advantages, the PALMETTO G-T Ring is now standard for Baldwin in this application.

CANNOT SPIRAL...

The Palmetto G-T Ring, unlike an O-Ring, will not twist and turn in the groove. T-form prevents spiral failure even in dynamic applications.

CANNOT EXTRUDE...



Resilient "T"-section supported by non-extrusion rings on either side makes extrusion impossible. As pressure is applied, non-extrusion rings are urged against cylinder wall, blocking the path of extrusion.

Write for our Manual MP-200, Engineering Standards for Palmetto Molded Packings. For design information on G-T Rings, see our catalog in Sweet's Product Design File.

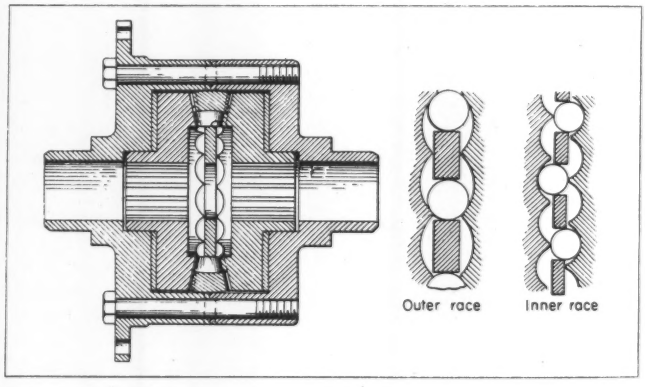
PALMETTO Packings

packing more performance into every application

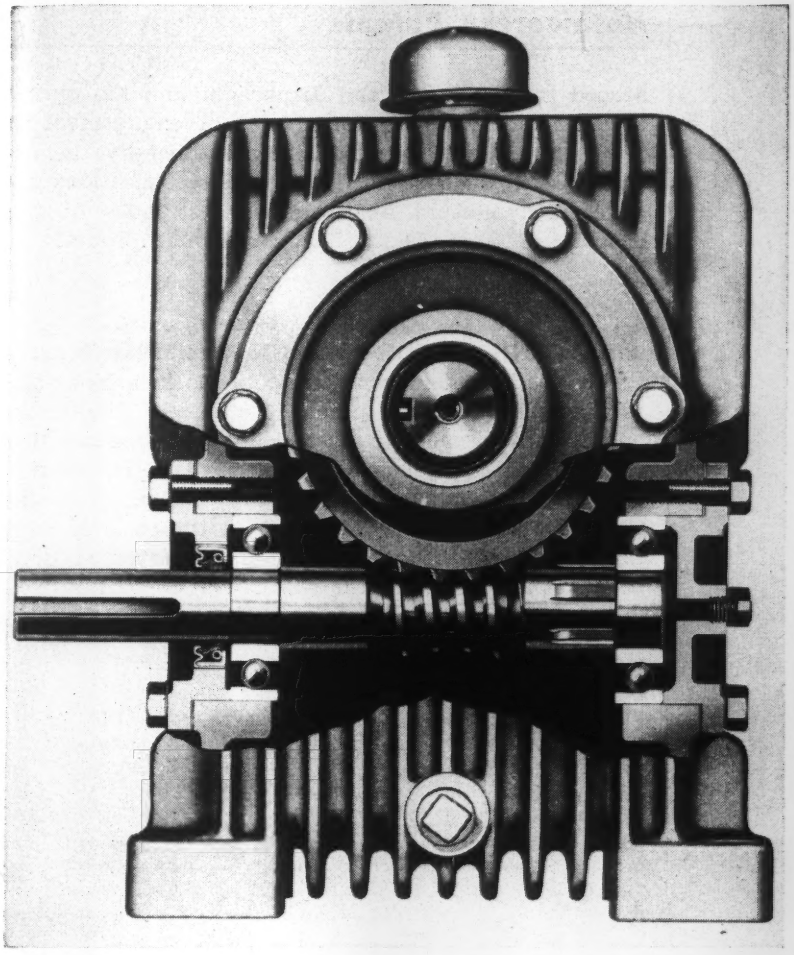
GREENE, TWEED & CO. North Wales, Pa.

NOTEWORTHY Patents

GEARLESS DIFFERENTIAL designed by R. R. Randall utilizes tapered rollers to divide power flow to the output members. Assigned to Detroit Safety Clutch Corp. and covered in patent 2,651,214, the drive assembly consists of two concentric rows of radial tapered rollers mounted in a cage between two circular output plates with concentric rows of radial grooves. Power is transmitted from the cage to the plates by roller pressure against the inclined groove sides. Accurate proportioning of the power flow to the plates in accordance with the resistance offered by the output members is assured by an offset groove arrangement which permits only one row of rollers to drive at a time. Under unequal power output conditions, the driving load is automatically shifted back and forth between the two rows of rollers, permitting relative motion between the plates. Groove construction is designed so that the transfer of driving action occurs just before a wedging angle is reached, eliminating the possibility of the plates locking. Friction losses are minimized by the design, which utilizes rolling instead of sliding forces over the comparatively large contact area obtained with the tapered rollers to provide high torque capacities in a compact unit.



UNIFORM SEALING ENGAGEMENT is maintained under variable end-load conditions with the shaft seal shown in patent 2,650,117. Assigned to Garlock Packing Co., the seal employs a flexible U-shaped rubber diaphragm; one leg is attached to the housing and the other carries a wear ring which engages a threaded shoulder on the shaft above the shaft surface. Positive sealing engagement is assured by a reinforcing sheet metal "spring" which is bonded to the diaphragm and prevents twisting of the seal under load. Irregular shaft end movements are ab-



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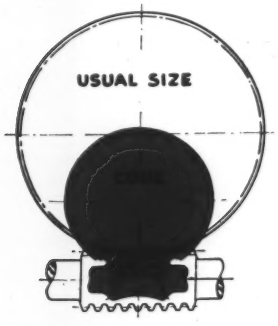
MORE HP PER CUBIC INCH

MORE HP PER DOLLAR

You're looking at the "innards" of the most efficient worm geared speed reducer available today. It's Cone-Drive Gear's exclusive double-enveloping worm gear design, which means more load-carrying capacity, size for size, than any other type of right-angle speed reducer.



This simple design, with the gear and worm literally "wrapped" around each other, means a space and weight savings that often makes the difference between a compact, efficient product and just another machine.

You can specify (from stock) any one of 190,000 standard models of Cone-Drive gears to handle loads from fractional to 800 hp. You can have ratios from 5:1 to 4900:1. Fan-cooled or water-cooled models available if you should need them.

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Division, Michigan Tool Company

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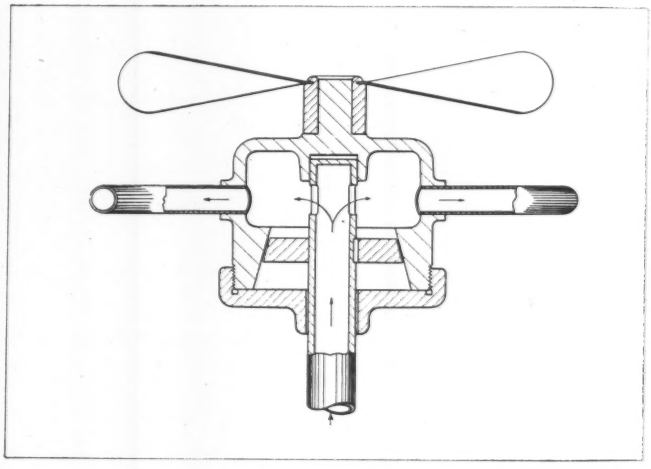
Noteworthy Patents

sorbed by flexing of the diaphragm and the spring action maintains a uniform force of engagement at the wear ring. Production is facilitated by the design which is described in several modifications for different mounting applications. Assignors of the patent are A. M. Chambers Jr. and L. F. Jones.

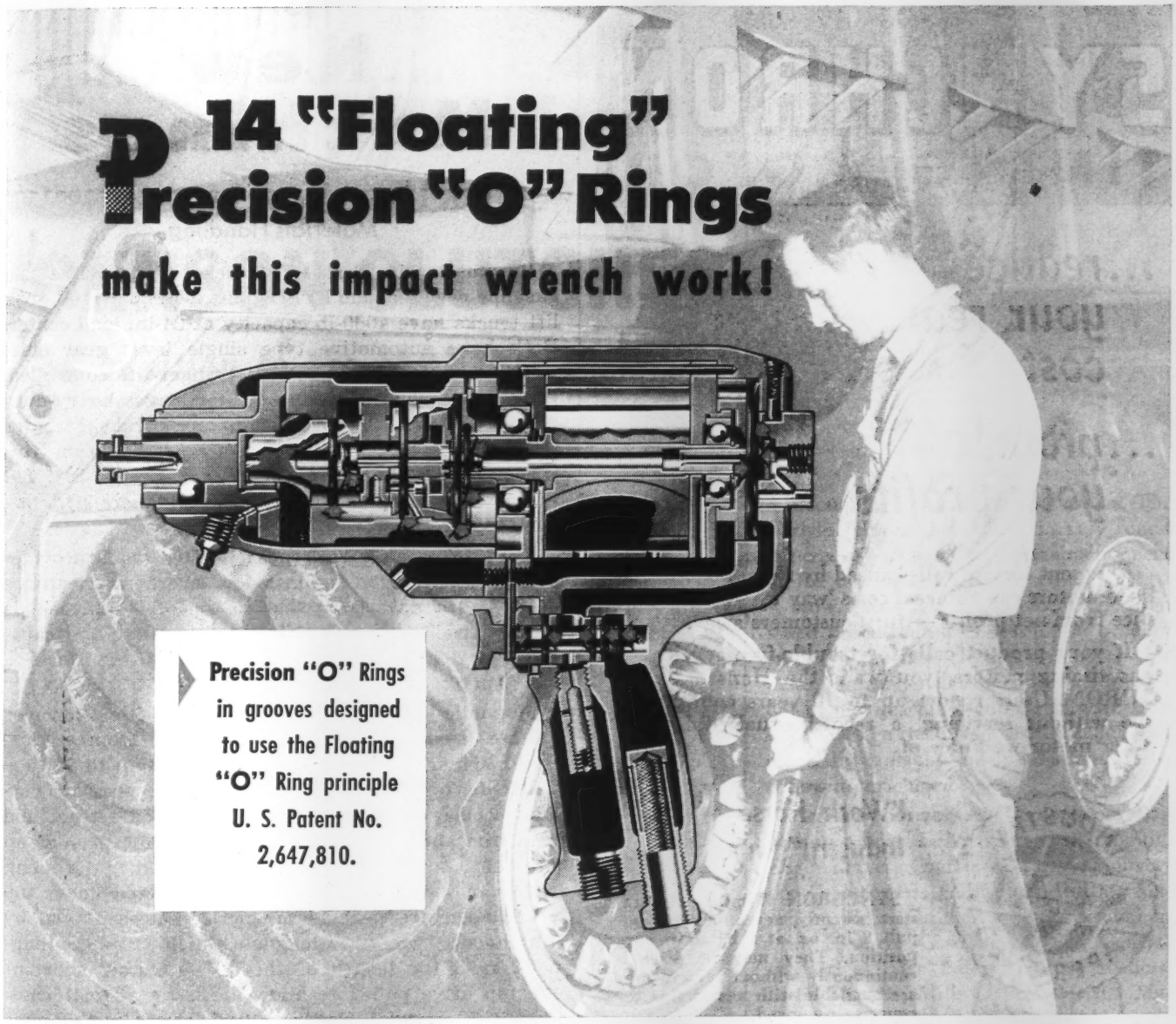
FLOATING ROTOR DESIGN minimizes bearing thrust loads and lubrication problems in a hydraulic turbine described in patent 2,652,228. Similar in operation and construction to Hero's original reaction turbine, the turbine designed by Richard H. Merrick employs a rotor journaled on the top end of a stationary vertical hollow shaft. With the rotor at rest, the weight of the rotor housing is supported by a beveled disk, keyed to the shaft, which engages mat-



ing tapered walls in the rotor fluid chamber. In operation, fluid under pressure enters the rotor chamber through openings in the shaft wall, producing a lifting force to "float" the rotor above its support. Part of the fluid is ejected through nozzles mounted to the rotor to create a driving torque; the remainder acts as a lubricant, flowing between the beveled surface of the disk support and the rotor walls to provide a liquid film at all contact surfaces. The patent has been assigned to Carrier Corp.

AUTOMATIC MISALIGNMENT COMPENSATION for instrument or small motor shafts is offered by a bearing construction covered in patent 2,652,293. Assigned to Self-Aligning Bearing Co. Inc. by Lewis H. Phillips, the design utilizes spherical-shaped journal bearings mounted in rubber seats in a stamped housing. Angular misalignment is accommodated by the spherical bearing shape which rotates in the seat to fit the shaft position. Minor variations in bearing dimensions are compensated by the rubber seat which also assures quiet operation and acts to lock the spherical bearings in place.

14 "Floating" Precision "O" Rings make this impact wrench work!



This rugged Impact Wrench is compact and efficient because it uses *Precision* Floating "O" Ring Seals. Master Pneumatic Tool Company of Orwell, Ohio, used a new design principle (U. S. Patent No. 2,647,810). The Sealing Assembly is designed so that the "O" Rings float in the grooves, pressing outward against cylinder walls. There is no cross sectional squeeze. This is a new way to reduce break-out friction, lower running friction and provide much longer life for "O" Rings in pneumatic service.

High quality, *compression molded Precision* "O" Rings have proved to be the best solution to a wide variety of sealing problems. How about *yours? Precision* leads the field in engineering help. Send for our complete handbook on "O" Rings and let us help *you.*

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...protect your profits

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SYNCHRON Timing Motors start instantly, never need oiling, pull 8 in. oz. at 1 RPM in any position. They may be stalled continuously without injury, and are available with gear trains to convert any speed.

Advanced engineering, tested materials and precise manufacture under rigid inspection and quality control, assure long lasting dependability and accuracy.

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Get complete, concise engineering data showing how easily SYNCHRON Timing Motors, Timing Machines, and Clock Motors may be applied to mechanisms now in production or still in the idea stage.

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New Machines

Materials Handling

Pneumatic Tire Fork Lift Trucks: Model FTP40-24, gasoline powered, and FTPD40-24, diesel powered, fork lift trucks have 4000-lb capacity at 24-in. load center. Both have automotive type single lever gear shift mounted on steering column; finger-tip controlled, flip-over parking brake; quick-change heavy-duty clutch; full floating, self-energizing brakes; center point steering. Both models are available in five standard mast heights with lifts of 72, 84, 108, 114 and 120 in. *Buda Co., Div. of Allis-Chalmers Mfg. Co., Harvey, Ill.*

Low-Clearance Fork Truck: Lo-Hed truck provides operator protection against low overhead clearance objects. Distance from seat to top of 68-in. mast is 36 in. Truck has 48-in. lift and is available in capacities of 2000, 3000 and 4000 lb. *Barrett-Cravens Co., Crescent Truck Div., Chicago, Ill.*

Magnetic Conveyor: Belt of magnetic conveyor elevates small ferrous parts and scrap from production machines to containers at inclines up to 72 deg. Conveyor operates with low discharge presses. Permanent magnets mounted under the bed attract and hold iron and steel parts in position as they move up the belt. Box channel main bed section is 4 ft long and is of ⅛-in. thick aluminum. Centered under top of the bed are parallel magnetic plates bridged by permanently energized magnets which carry the magnetic field the length of the bed, stopping short of the top drive pulley to allow discharge of materials. Belt is 10-in. wide Neoprene with cleats of the same material stitched on at 12-in. intervals. Belt speed is 75 fpm. Mounted on a 24 x 30-in. base, the conveyor has four 3½-in. diameter wheels. Jack screw adjustment on the stand permits setting discharge height at any point from 38 to 56 in. *Rapids-Standard Co. Inc., Grand Rapids, Mich.*

Narrow-Aisle Fork Truck: A modified straddle model with four base legs, this truck has 5 x 2-in. load wheels which straddle the pallet while the 7-in. wide elevating forks lower over another set of base legs with dual 5 x 2-in. wheels. Stability at elevated heights up to 158 in. is provided. Truck can stack pallet loads at right angles from 6-ft wide aisles. It is used with skids, open-face or four-way entry block type pallet where high lifts are required. *Raymond Corp., Greene, N. Y.*

Metalworking

Centerless Grinder: Self-integrated unit operates as a through-feed, in-feed, crushed form or template diamond dressed form grinding machine. In-feed grinding adapts the machine for producing formed, tapered or concentric multiple diameter work. Accuracy can

(Advertisement)

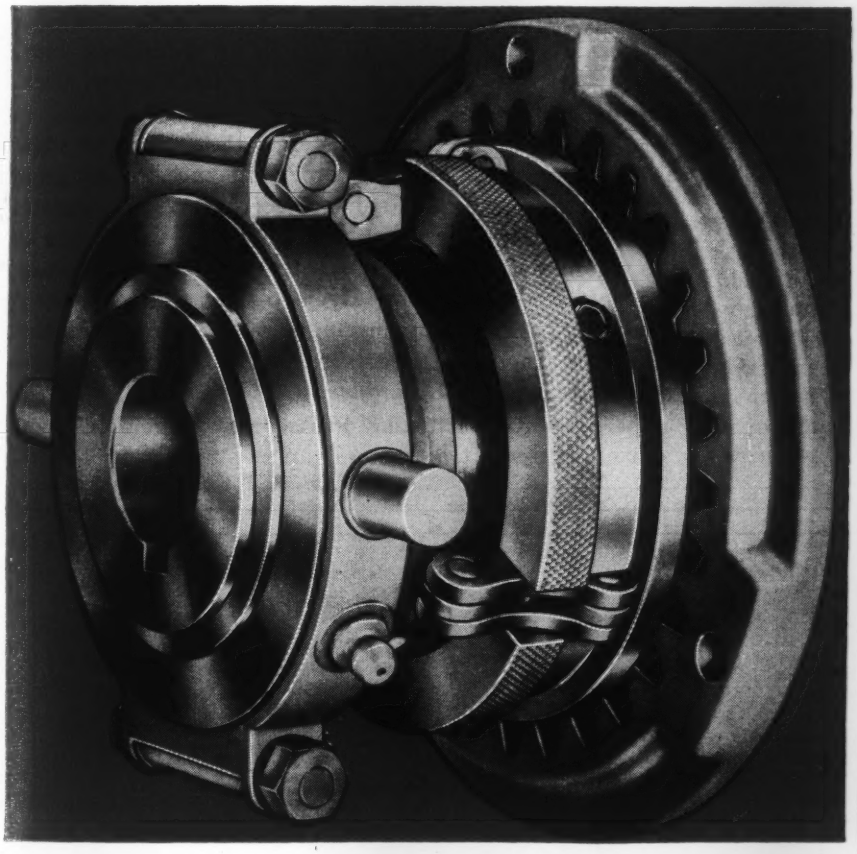
ANNOUNCING.....

THE NEW LOW COST

single disc

JOHNSON CLUTCHES

an addition to the* MAXITORQ *line



The Johnson 350 and 450 Single Disc Clutches are the newest additions to the Carlyle Johnson line... fitting companions to the Maxitorq multi-disc series.

They are ideal for light machinery service to 6 H.P. Several driving combinations are available, including V-belt. Far greater capacity at low cost is provided. (See column at right for typical applications.) They have the same "floating disc" principle as the Maxitorq Clutch... discs that ride free in neutral... no drag, no abrasion, no heating. A simple hex-key frees the knurled ring for easy manual clutch adjustment. Machine designers will find the solution to many problems with this new Johnson Clutch.

Send for Bulletin
MD6-250

1C/53

Frankly
SPEAKING

Because of a large backlog of orders, The Carlyle Johnson Machine Company found it necessary to postpone the announcement of the new Johnson Single Disc Clutches.

Now, with added equipment for high speed production, it is possible to produce and ship the new clutches without undue delay. In fact, small orders or units for try-out in new machines will be forwarded at once. Design features make the Johnson especially suitable for installation in the following machinery:

Accessory Drives, Air Compressors, Bag Making, Boat Drives, Bread Wrapping, Chain Drives, Combines (farm), Conveyors, Crop Seeders, Cultivators, Dusting Machines, Feed Grinders, Floor Scrubbing, Fruit Cleaners, Gasoline Engines, Generator Drives, Hay Balers, Hoists, Loaders, Lawn Mowers, Milk Coolers, Mixing Machines, Motor Scooters, Packaging Machines, Paper Shredders, Power Fans, Power Saws, Power Take-Offs, Pumping Equipment, Sand Spreaders, Sewing Machines, Sheep Shearers, Spraying Equipment, Textile Machinery, Threshers (small), Tobacco Machinery, Tool Grinders, Tractors (garden), "V" Belt Drives, Vegetable Sorters.

Naturally, these are but a few of the possible applications for the Johnson Single Disc Clutch. The field is wide open, with new machinery constantly being developed.

Included in the driving combinations are: Gear Tooth, Bolted Plate, Pulley Type, Hub Adapter, Cut-Off Coupling Adapter, Single V-Belt Pulley Drive, and Double V-Belt Pulley Drive.

Carlyle Johnson engineers offer their engineering assistance in cooperation with your engineers and machine designers to develop the correct solution of your power transmission requirements. Write to Frank R. Simon, The Carlyle Johnson Machine Co., Manchester, Conn.

be held to 0.0001-in. Work capacity is from $\frac{1}{16}$ to $\frac{5}{8}$-in. diameter on steel and up to 1 in. diameter on nonferrous, ceramics, carbon, glass, cork, rubber, plastics and other low tensile strength material. The 12 x 2½ x 5-in. grinding wheel is driven by a 3-hp motor, and the 7-in. feed wheel, by a separate ½-hp geared motor with speeds of 21, 42 and 320 rpm. *American Herforder Corp., Chicago, Ill.*

Air-Operated Shear: Portable type B air shear, for cropping ferrous and nonferrous hot bars, crops up to 1¼-in. diameter hot rounds at any air pressure between 60 and 100 psi. It has four-edged knives with setscrews for adjustment after grinding. Unit operates automatically only at the time of actual cutting. It requires floor space of 16 x 33 in.; weighs under 1500 lb. *Curry Air Shear Corp., Pittsburgh, Pa.*

Internal Gear Shaver: Model GCR finishes internal spur and helical gears from 3 to 12-in. pitch diameter. Gears having up to 4 diametral pitch teeth and face width up to 2½ in. can be shaved. Precision differential automatic upfeed mechanism includes a master cam which acts as step gaging device to control feed increments, finished size and return to backlash position. Either conventional or plunge-cut shaving can be performed. In latter method, work drives the cutter as with conventional method, but cutter is fed to depth without reciprocation. Workhead can be locked in positions up to 1½ deg each side of a vertical centerline to permit taper shaving operations. Optional pivoted workhead mounting permits head to pivot upward at a 30-deg angle to the cutter centerline, permitting long-stemmed gears to be loaded and unloaded. Machine is 62½ in. wide, 39¾ in. deep and 64 in. high. *National Broach & Machine Co., Detroit, Mich.*

Surface Grinder: No. 10 reciprocating table grinder, designed for gage and form tool work as well as surface grinding, is available with hand or mechanical feed. Longitudinal table travel is 20 in.; transverse table travel, 7 in.; vertical travel of grinding wheel, 15 in. It will grind work 6 x 18 x 15 in. high under a 7-in. grinding wheel driven by any 1-hp motor-driven spindle. Table speed is 15 to 50 fpm. A 1/6-hp, 1200 rpm reversing motor drives table through variable-speed pulleys. Elevating and transverse movements can be equipped with indicator gages for use with gage blocks or measuring rods, for close work. *Covel Mfg. Co., Benton Harbor, Mich.*

Tube Cutter: Automatic machine cuts tubes to ⅜-in. or longer lengths, leaving a flat, unburred edge. Tubes in a wide range of stock thicknesses and from ⅜-in. to 2 in. in diameter are accommodated. Special adapters for larger tubes are available. Cuts tubes of such materials as mild steel, stainless steel, brass, copper and aluminum. Cycle takes approximately 1 second, depending upon length of piece and diameter and thickness of tube. *Brehm Div., Steel Products Engineering Co., Springfield, O.*

Open-Back Inclinable Presses: Available in eight sizes with shaft diameters ranging from 3 to 7½ in.,

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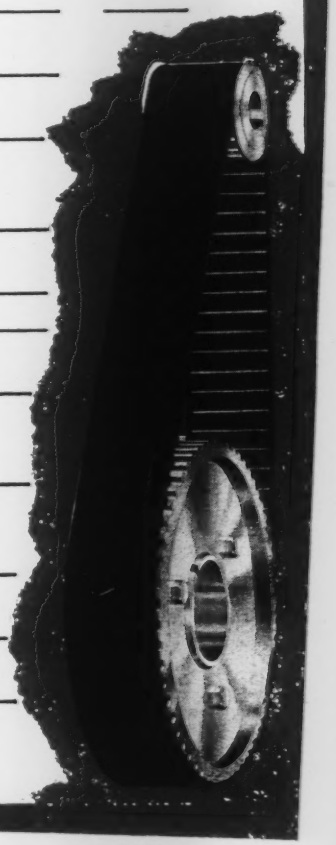
Make your own comparison of the

Gilmer THE ORIGINAL "TIMING"® BELT DRIVE

versus other forms of Power Transmission

	GILMER "TIMING" BELT DRIVE	FLAT BELTS	CHAIN	V BELTS	GEARS
1. Can it transmit 1/100 to 300 HP without slippage . . . and without lubrication?	Yes				
2. Does it eliminate noise and vibration caused by metal-to-metal contact?	Yes				
3. Does it operate at maximum efficiency, indefinitely, without take-up?	Yes				
4. Does it make possible very compact, short-center drives of ratios up to 15-to-1?	Yes				
5. Does it eliminate need for initial tension, permitting all the drive's tension to be used effectively . . . and reducing bearing wear?	Yes				
6. Can it operate satisfactorily at peripheral speeds above 12,000 FPM?	Yes				
7. Does it maintain constant angular velocity?	Yes				
8. Is its weight very low in proportion to its strength?	Yes				
9. Does it make possible precise "timing", without appreciable backlash, between two or more widely separated shafts?	Yes				
10. Does it eliminate the expense and added weight of lubricants, lubricating devices and covers?	Yes				
11. Does it save so much power as to sometimes permit use of lower-powered motors?	Yes				
12. Does it have unusually long, maintenance-free service life?	Yes				



WHEN PLANNING A DRIVE, CONSIDER ALL FIVE!

NEOPRENE-ENCASED, CABLED STEEL WIRE GIVES THE BELT GREAT STRENGTH WITHOUT BULK

Naturally, these questions are phrased to emphasize the unique *combinations* of features provided by the "Timing" Belt drive. Question 1, for example, might have been divided into two separate questions. But this would not point up the important fact that the "Timing" Belt drive is the *only positive drive requiring no lubrication.*

Certainly, the four older types of drives will always have their special places in the power transmission picture. The important fact is that the design engineer now has at his disposal a *fifth* type of drive ideally suited to so many applications that more than a million are now in use.

Write for your copy of the Gilmer "Timing" Belt Stock Drives Manual, to Gilmer "Timing" Belt Division at the address below.

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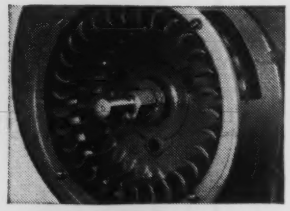
Performance Features

WISCONSIN Heavy-Duty engineering design and construction provide the dependable "Lugging Power" that enables these engines to outperform high-speed power units. When variable or "shock loads" occur, WISCONSIN Lugging Power *hangs on*, where engines of light-duty, high-speed design will stall. *Your Wisconsin Engine keeps the machine going.*

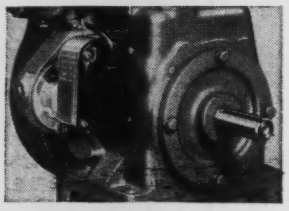


TROUBLE-FREE, ALL WEATHER AIR-COOLING . . .

No machine is any better than the Power that drives it. And efficient cooling, under all operating conditions, is one of the first essentials to *dependable power!* A large capacity fan, cast in the flywheel of every Wisconsin Engine, provides trouble-free cooling, even in the most extreme temperatures.

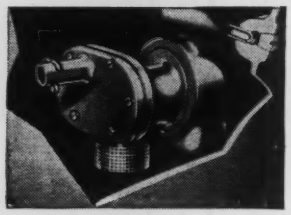
TAPERED ROLLER BEARINGS AT *BOTH ENDS* OF CRANKSHAFT . . .

These self-cleaning, file-hard bearings take up all load thrusts, permitting the use of either chain-, belt- or gear-drive direct from the extended crankshaft, without fear of damaging main or connecting rod bearings. This does away with the need for an outboard bearing.



HIGH TENSION, ROTARY TYPE OUTSIDE MAGNETO . . .

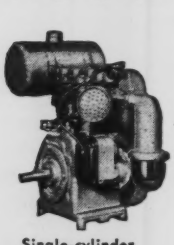
Positive gear drive direct from camshaft assures steady, uniform ignition at all times. The complete unit is conveniently mounted on the OUTSIDE of the engine for easy accessibility. Weather-sealed against moisture and dust. Equipped with Impulse Coupling for quicker, easier starting at all seasons.



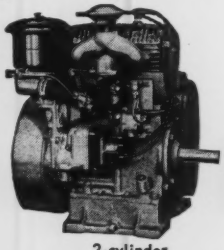
POSITIVE, PUMP-CIRCULATED LUBRICATION . . .

All single cylinder models (with exception of Model AEN) have pump-circulated level splash system. Model AEN and multi-cylinder models pump an individual oil stream to each connecting rod. Other parts are lubricated by oil spray, assuring complete and thorough lubrication for smooth-running and long engine life.

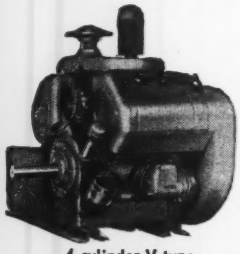
These are some of the reasons why it pays to specify "WISCONSIN ENGINE POWER" for your equipment. Engineering and descriptive data gladly supplied.



Single-cylinder 3 to 9 hp.



2-cylinder 7 to 15 hp.



4-cylinder V-type 15 to 36 hp.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A 7860–½AA

New Machines

Series AA presses have electrically controlled, pneumatically actuated clutches, which may be engaged or disengaged at any point in the stroke. Clutch has no friction members and can be single stroked, jogged or run continuously. It stops automatically if power or air pressure fails. Utilized for blanking, forming, drawing, perforating and in combination die and automatic feeding operations, presses may be fed from either side or from front or back. *Niagara Machine & Tool Works, Buffalo, N. Y.*

Tube Cutoff Machine: One horizontal and one vertical blade are employed to make 6000 cuts per hour. Machine cuts tubing of any diameter up to 2 in. of any ordinary wall thickness and of any shape. Cuts are accurate to $\pm$0.002-in. Feed rate is 600 fpm. Precision clamping dies hold the tubing during $\frac{1}{3}$-second cutting time to prevent distortion and to reduce the burr. Machine cuts steel, copper, brass, aluminum, stainless and various other metal alloy tubing to lengths of 1 in. or more. *Grieder Industries Inc., Toledo, O.*

Plant Equipment

Portable Milling Machine: For maintenance work on heavy machinery, 900-lb unit is used on equipment such as press beds; hammer bases, without removing columns; punch press die beds; ways and steel rolling mill columns. Face, front, die seat and other surfaces on upsetters can be refinished, as well as surfaces which are at 90-deg angles from each other. *Atlas Portable Machine Sales Corp., Hazel Park, Mich.*

Metal Cleaner: Bench model Jet Blast cleaner removes rust, scale and all types of foreign deposits from dies, molds, tools and other precision articles without dimensional alterations. Cleaning method employs fine abrasive particles suspended in a liquid and propelled by means of a high-velocity air stream. Moving parts do not come into contact with the abrasive. One or two blast guns may be used with 28 to 42 cfm of air at 85 to 100 psi. Liquid capacity is 2 gal; abrasive capacity, 13 lb. Unit is 24 in. in diameter, 43 in. high and weighs 155 lb. *R. W. Renton and Co., Cleveland, O.*

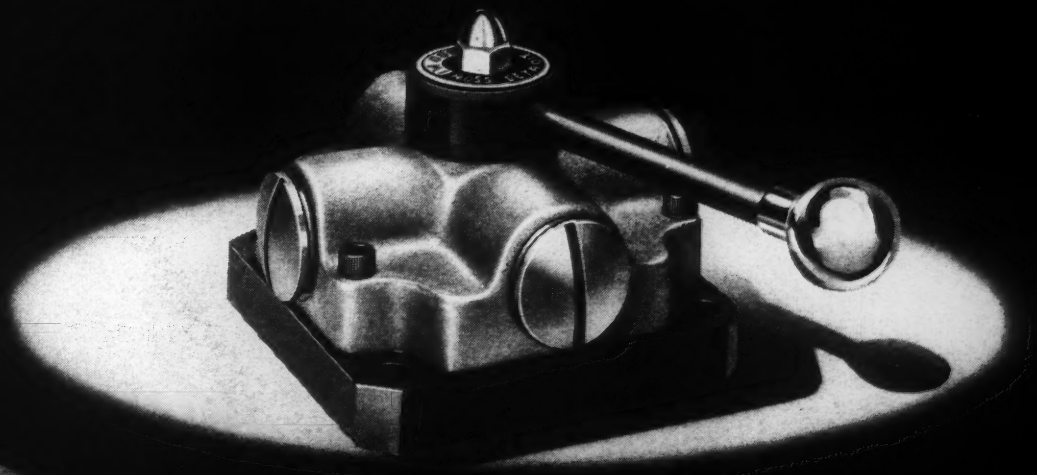
Sump Tank Cleaner: Portable model 20-T cleans all chips, abrasives, sludge, old oil and coolant from sump tanks of machine tools using cutting oil or coolant, then cleans the oil and returns it to the sump. Sumps are vacuum-drained; only air passes through the pump, eliminating clogging and excessive wear of the pump. Average weight oil is removed and cleaned at the rate of 20 gpm. Cleaned oil passes into the storage tank. When the sump tank is emptied, the pumping unit is reversed and air pressure developed by the exhaust side of the vacuum pump discharges cleaned oil or coolant back into the machine sump. Made in tank capacities of 100 and 150 gal, cleaner has 100-lb capacity sludge basket. *W. R. Carnes Co., Verona, Wis.*

Drill Sharpener: Crankshaft drill point grinder provides a method of grinding crankshaft points on drills ranging in size from No. 1 through 50, A through U,

IT'S NEW . . .

IT'S FOR MACHINE TOOLS . . .

it's a "pancake"—2" high



ROSS Introduces Poppet Valve *with Rotary Handle Action*

- Seals with air pressure
- Easy to operate
- Smartly styled, clean, neat in appearance
- 4-way unit available in ¼ and ⅜ inch pipe sizes

Write today for Bulletin 507

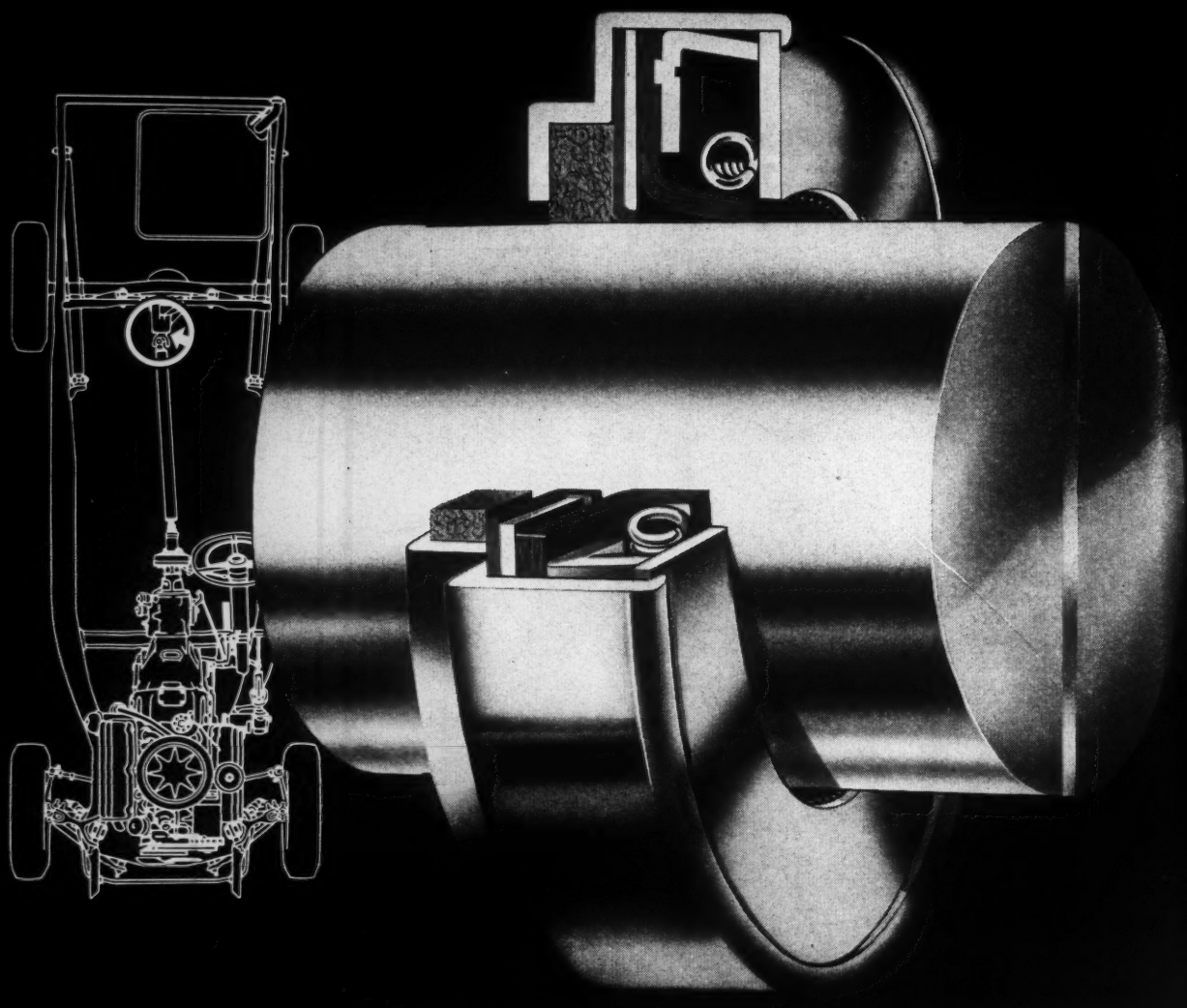
Ask Ross for Any Air Control Information

Ross makes valves only—hundreds of types and sizes. Take advantage of the experience gained in over a quarter century of concentration on control and application of air power!

ROSS OPERATING VALVE COMPANY

Air Control

109 E. GOLDEN GATE AVE., DETROIT 3, MICHIGAN



TAKES THE HEAT OFF TOUGH JOBS Operating temperatures were lowered significantly, with resultant savings in power and increased service life when a C/R oil seal with a **Conpor** leather sealing element was used as the pinion shaft seal in one of the current fine automobiles. Whether your sealing problem is for a severe or simple application . . . whether it calls for leather with controlled porosity, or specially compounded elastomers, discuss it with C/R engineers. They will gladly cooperate on special designs or help you choose from 17 standard types and 1800 sizes. Write for your copy of "Engineering with C/R Oil Seals."

C/R

PERFECT

Oil Seals

See Sweet's Product Design File 3h / Ch

CHICAGO RAWHIDE MANUFACTURING COMPANY

1301 Elston Avenue OIL SEAL DIVISION Chicago 22, Illinois

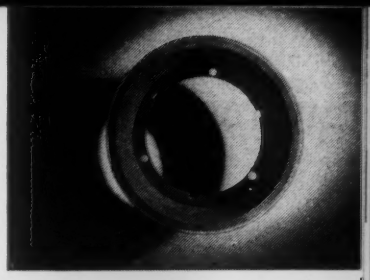
Representatives in these Principal Cities: Boston • New York • Syracuse • Buffalo • Philadelphia • Pittsburgh • Cincinnati • Cleveland Detroit • Peoria • Minneapolis • Wichita • Tulsa • Houston • Los Angeles • San Francisco • Seattle • Spokane • Portland

MANUFACTURED AND DISTRIBUTED IN CANADA BY SUPER OIL SEAL MFG. CO., LTD., HAMILTON, ONT.

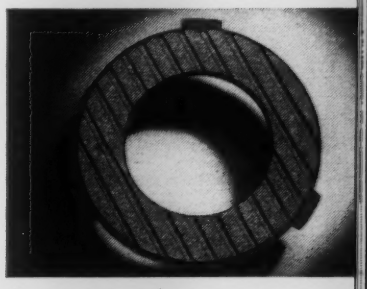
Other **C/R** *products*

Sirvene: (Synthetic rubber) diaphragms, boots, gaskets and similar parts for critical operating conditions • Conpor: Controlled porosity mechanical leather packings and other sealing products • Sirvis: Mechanical leather boots, gaskets, packings and related products.

ARMSTRONG FACINGS are standard on automotive clutches designed to operate at 300° F. In summer, ambient oil temperature often reaches 325° F., stays there for hours without harm to facing.



Drill press tapper cone clutch runs dry, allows almost instantaneous engagement for maximum production rates.



Use of cork in washing machine's wet clutch cut needed facings from 8 to 3.

Cork-and-rubber facing gives motorcycle fast getaway, even on sandy roads, saves seconds on each shift.

CORK CLUTCH FACINGS:

High torque capacity at up to 300° ambient oil temperature

Many wet clutches with cork facings are run regularly at ambient temperatures in the 250°–350° F. range, almost double the commonly accepted textbook standard. In fact, flash temperatures during engagement actually go even higher without damage to the facing.

Cork's high coefficient of friction over a wide range of temperatures and pressures gives you extremely high torque capacity for a given facing area. By using cork, you can usually reduce the number or size of plates needed in a clutch, or run it at a lower engagement pressure without sacrificing torque capacity. In addition, cork facings reduce assembly costs and eliminate the need for finishing grinding, so the savings possible with cork are often sizable.

Cork facings are durable, too. In fact, ten different makes of automobiles now have Armstrong-made cork facings in their automatic transmissions. Experience has shown that these facings will run for the life of a car without wearing out or breaking down.

Armstrong is the world's leading supplier of cork-compounded facings. A wide variety of cork composition, cork-and-rubber, and cork-fiber friction materials are available from Armstrong . . . as well as unique testing facilities which help you select a facing with a minimum of time and trouble.

For the complete story on cork-compounded facings, or for specific help in picking a facing for a new clutch design, write Armstrong today. Address Armstrong Cork Company, Friction Materials Department, 7206 Dean Street, Lancaster, Penna.

ARMSTRONG'S FRICTION MATERIALS

they had to be certain...

So INTERNATIONAL HARVESTER chose RICHARDSON to mold this plastic distributor cap

When a manufacturer like International Harvester uses a part for all the tractors, power units, and implements it produces—the figure runs into hundreds of thousands a year. And because each part has to conform to rigid I-H engineering specifications—it has to be *right*, too!

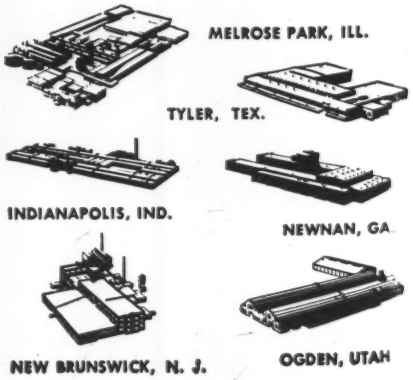
Obviously, I-H must turn to a plastics molder who has facilities for large-scale production and who can offer precision molding skill and the assurance of uniform quality combined with delivery as scheduled.

And that's why Richardson was selected to mold this plastic distributor cap.

For a quarter century, Richardson has been handling the "tough ones" for International Harvester. Why not turn to Richardson when you have a tough plastics job?

INSUROK®

MOLDED & LAMINATED PLASTICS



The RICHARDSON COMPANY

FOUNDED 1858—LOCKLAND, OHIO

2795-J Lake Street, Melrose Park, Illinois (Chicago District)

SALES OFFICES IN PRINCIPAL CITIES

Facts you should know about DE LAVAL *worm gearing*

How master worm control gives you 4 vital advantages

This photograph shows inspector making a final check of contact and backlash on a De Laval gear set which has been process-inspected all along the line. A De Laval master worm "rides" with every job . . . insures start-to-finish quality control.

Since De Laval maintains a wide range stock of master worms as reference standards, you can be sure of:

- **Unvarying uniformity**
- **Correct thread thickness**
- **Preciseness of tooth contour**
- **Interchangeability of parts**

De Laval manufactures heavy duty worm gear sets in *ratios from 3:1 to 100:1, with ratings of .1 hp to 550 hp and center distances from 3" to 36".*

A New Working Tool for You!

Worm Gear Sets Catalog 5000 contains 38 pages of vital data. Write for your copy on your business letterhead.

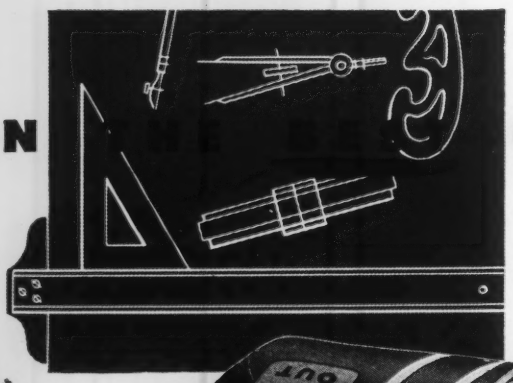
DE LAVAL *Worm Gear Sets*

DE LAVAL STEAM TURBINE COMPANY

858 Nottingham Way, Trenton 2, New Jersey

DL 224

EVEN [illegible] CAN BE IMPROVED



Gerotor offers its New QDB series of small capacity pumps as proof!

Gerotor has redesigned its series of small capacity pumps to give even more . . .

- **FLEXIBILITY**—the QDB can be operated in either clockwise or counterclockwise direction by simply changing the position of one internal plug!
- **RANGE OF APPLICATION**—the QDB can be obtained with an extended shaft to operate another pump in tandem, off of one motor!
- **DEPENDABLE SERVICE**—the QDB is built to give more dependable service over a longer service span than any comparable pump. Its longer life reduces your maintenance and replacement costs.

If you have need for pumps in the QDB range, call on Gerotor.

Gerotor makes a complete line of hydraulic pumps in ranges from .4 g.p.m. to 40 g.p.m. The Gerotor engineers can help you solve your hydraulic pump problems. Write for *free literature* and full particulars.

Check this capacity table . . .

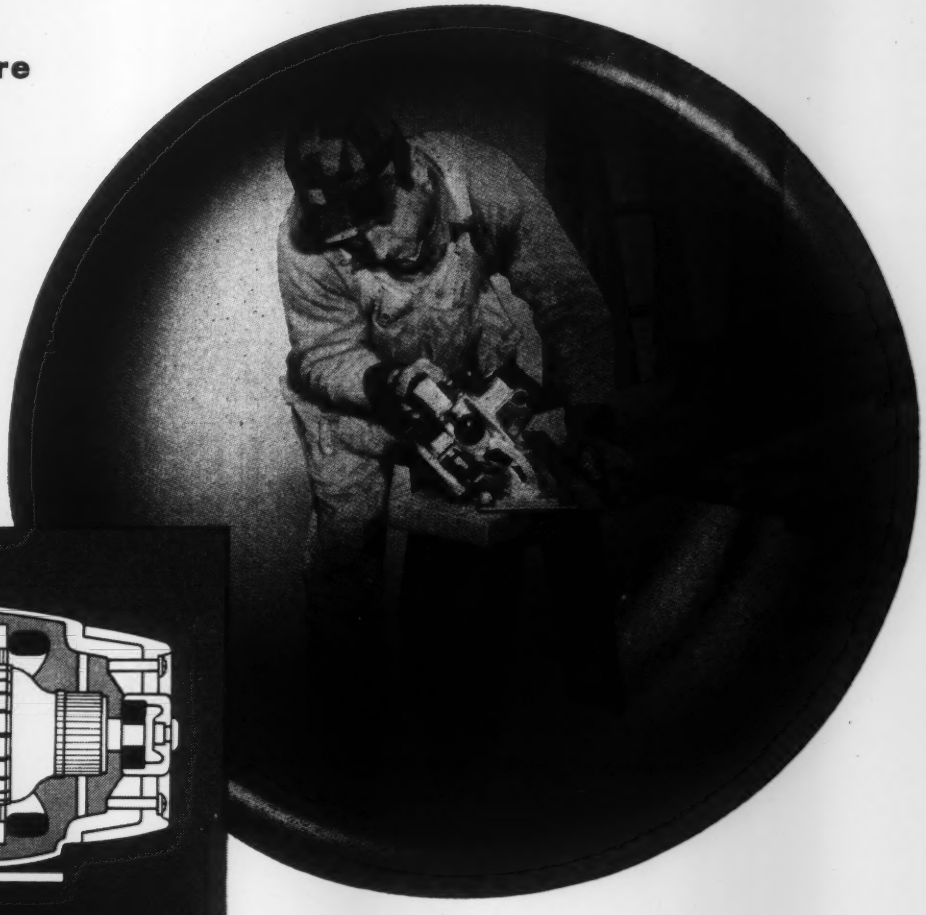
Type	Delivery g.p.m.—1800 r.p.m. Discharge Pressure p.s.i.				
	0	250	500	750	1000
QDB .4	.42	.40	.38	.35	.31
QDB .75	.84	.80	.78	.73	.66
QDB 1.5	1.67	1.62	1.57	1.50	1.42

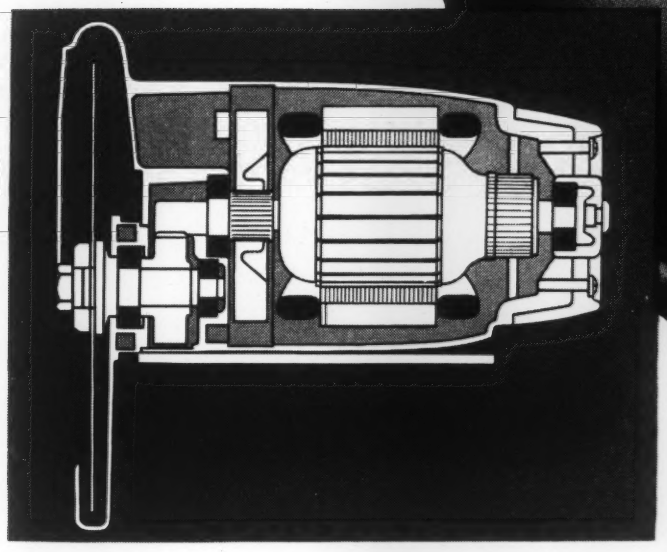
GEROTOR MAY CORP. - Box 86 - Baltimore 3, Md.

GEROTOR
HYDRAULIC PUMPS & MOTORS

BUILDING BOON!

New Departures assure smooth, high-speed operation for Porter-Cable tools!



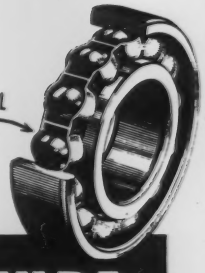


Four New Departure ball bearings in Porter-Cable's No. 115 saw contribute importantly to its dependable, trouble-free operation.

Long hours of heavy work without letup! New Departure precision **ball** bearings help keep Porter-Cable's No. 115 saw on the job. These bearings preserve alignment of moving parts under all conditions . . . require almost no upkeep . . . assure smooth, clean cutting and a cool-running motor for hours on end.

New Departure **ball** bearings bring advantages like these to hundreds of machines and appliances. Whether improving a product or designing a new one, *talk with your New Departure engineer.* He'll help you get maximum efficiency and economy in bearings.

NOTHING ROLLS LIKE A BALL



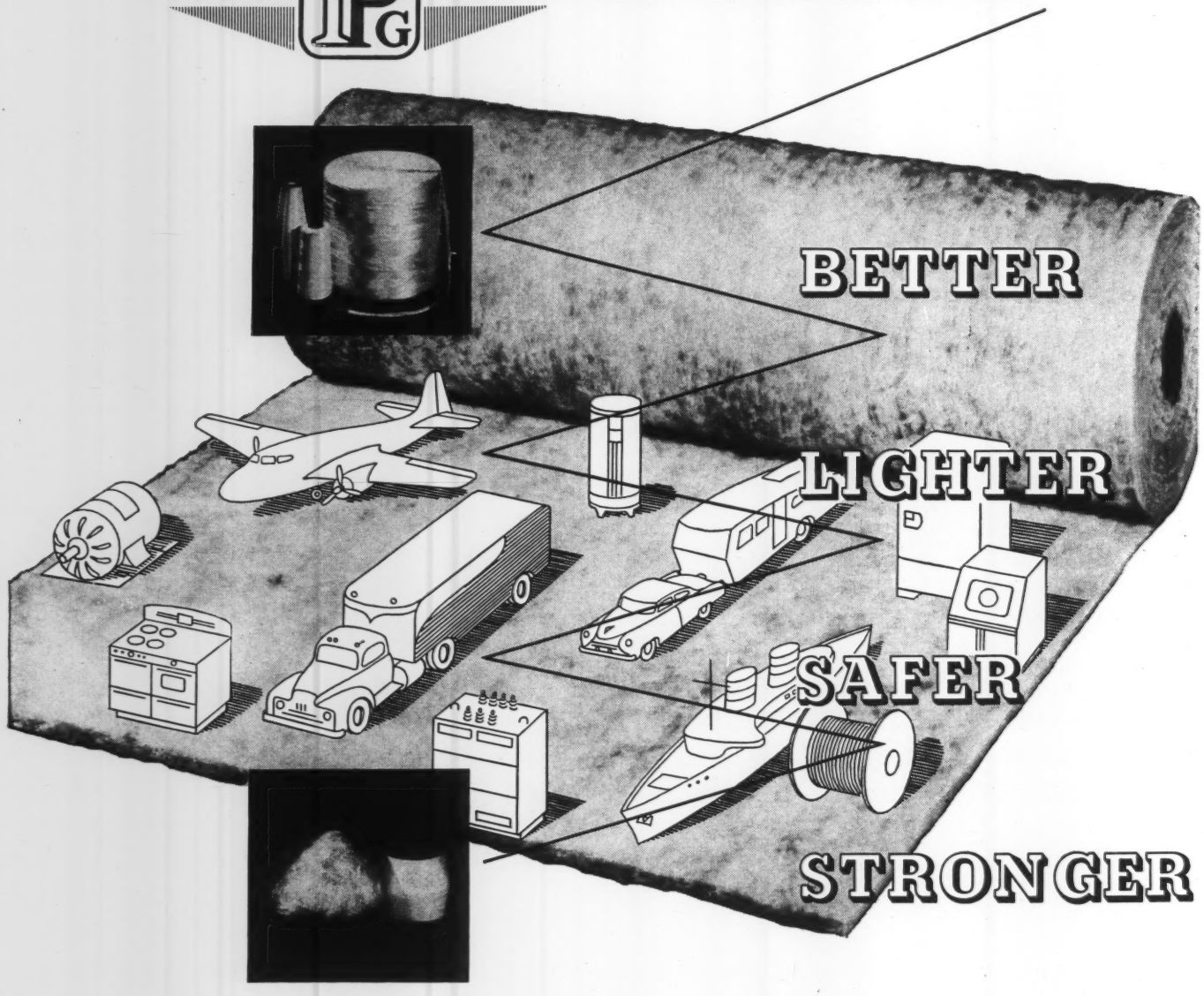
NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL CONNECTICUT
Plants also in Meriden, Connecticut, and Sandusky, Ohio
In Canada: McKinnon Industries, Ltd., St. Catharines, Ontario

NEW DEPARTURE SALES ENGINEERING OFFICES—AT YOUR SERVICE

BRISTOL	269 North Main St.	2-6371	**DETROIT**	7-122 General Motors Bldg.	Trinity 2-4700	**KANSAS CITY**	1021 E. Linwood Blvd.	Valentine 4939
BOSTON	517-A Park Square Bldg.	Hancock 6-9867	**CINCINNATI**	2107 Carew Tower	Main 5783	**MILWAUKEE**	647 W. Virginia St.	Broadway 6-9460
KANNAPOLIS, N. C.	P. O. Box 1086	2-3181	**CLEVELAND**	3113 W. 110th St.	Winston 1-5454	**ST. LOUIS**	3001 Washington Blvd.	Franklin 6533
NEW YORK	1775 Broadway	Circle 6-1540	**INDIANAPOLIS**	1357 W. 18th St.	Imperial 4680	**LOS ANGELES**	5035 Gifford Ave.	Logan 8-2301
PHILADELPHIA	850 E. Luzerne St.	Garfield 3-4136	**PITTSBURGH**	Cathedral Mansions	Mayflower 1-8100	**BERKELEY**	1716 Fourth St.	Landscape 6-8750
SYRACUSE	2360 James St.	73-5195	**CHICAGO**	332 So. Mich. Ave.	Wabash 2-5875	**SEATTLE**	5000 First Ave., S.	Lander 5920
			DAVENPORT	2212 E. 12th St.	Davenport 7-7522			

FIBER GLASS HELPS MAKE PRODUCTS



Perhaps your product needs lightweight, space-saving thermal and acoustical insulation. Or you may be interested in the strongest of all plastic reinforcements, or electrical insulations that prolong the life of apparatus, or a fiber for producing flame-proof textiles that may be as sheer or as rugged as your use requires. Pittsburgh Fiber Glass can meet any of these needs—and many more—with performance that makes products better, safer, lighter, stronger.

We'll be glad to give you complete product data and information on facilities for serving you. Technical assistance is also available. Pittsburgh Plate Glass Company, Fiber Glass Division, 420 Duquesne Way, Pittsburgh 22, Pa. District Sales Offices: Chicago, Cincinnati, Cleveland, Detroit, New York, Washington.

SUPERFINE INSULATION—"AA" and "B" fibers in a complete range of blanket roll sizes, thicknesses, densities, facings.

YARNS, ROVING and STRANDS—Made with the continuous filament process to an exceptional degree of fiber uniformity.

FIBER GLASS **PAINTS • GLASS • CHEMICALS • BRUSHES • PLASTICS**

PITTSBURGH PLATE GLASS COMPANY

BEVEL and Mitre Gears

To make the best bevel and mitre gears — the largest battery of No. 24 Gleason Bevel and Mitre gear generators* in the world — operates in the Illinois Gear & Machine Company's plants.

This is another of the many reasons why "Illinois Gear" is the World's largest producer of high quality gears of every type.

*All of these generators cut "CONIFLEX" tooth form.

ILLINOIS GEARS U S Pat Off

Gears for Every Purpose ... one gear or 10,000 or more

ILLINOIS GEAR & MACHINE COMPANY

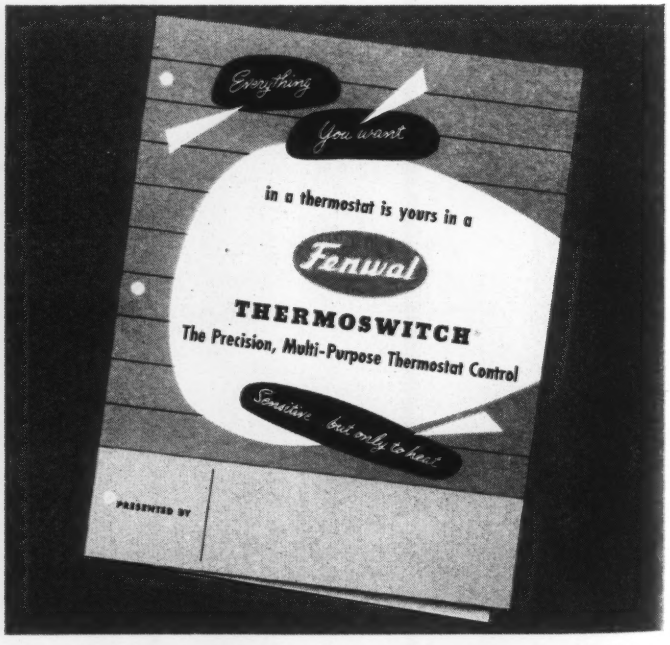
2108 NORTH HATCHIE AVENUE • CHICAGO 39, ILLINOIS

How would YOU solve these two problems?

1. A PATCH AHEAD OF TIME, applied at the factory, reinforces the knees of dungarees and overalls. Patches are vulcanized under pressure with Radio Frequency Corp.'s high frequency, dielectric heater. If dielectric heat, generated in the material, is lost through conduction, vulcanization becomes inefficient. But Fenwal THERMOSWITCH® units in each platen minimize these losses by close temperature control. Vulcanizing 3000 patches per hour is now standard; 30 was.

2. DENTAL PLATE FIT STARTS WAY BACK. The tiny abrasive wheels for grinding and polishing dental plates must be very accurately molded of fine abrasive in a rubber base. The molds in which they're made must have delicate temperature control for consistent quality and uniformity. The manufacturer, The Wm. R. Hall & Son Co., uses THERMOSWITCH units in molds for accurate, reliable temperature control. Production figures can be kept high while rejects are low.

3. THIS IS IT — the Fenwal THERMOSWITCH control is simple — compact shell contracts or expands *instantly* with temperature changes, opening or closing electrical contacts. Adjustable and highly resistant to shock and vibration. Fenwal THERMOSWITCH units are solving temperature problems and helping to improve the final product throughout all industry.



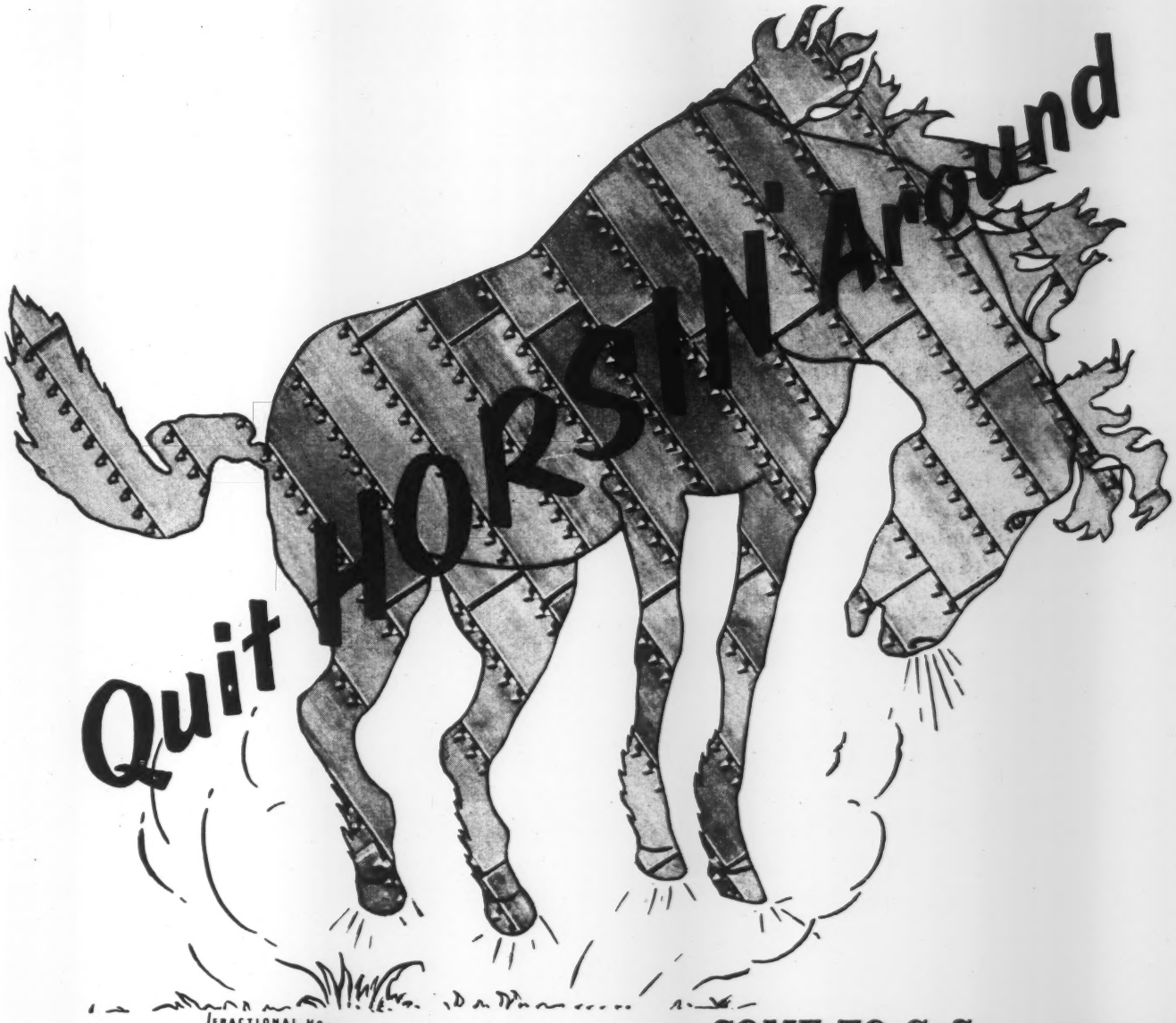
4. SEND FOR THIS BROCHURE for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write Fenwal Incorporated, 196 Pleasant St., Ashland, Massachusetts.

Fenwal

THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE... *but only to heat*



FRACTIONAL HORSEPOWER GEARING

GEAR Specialties, Inc.

2635 WEST MEDILL AVENUE
CHICAGO 47, ILLINOIS

SPURS • SPIRALS • HELICALS • BEVELS • INTERNALS
WORM GEARING • RACKS • THREAD GRINDING

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARING

COME TO G.S. . . YOU CAN DEPEND UPON THE PERFORMANCE OF THE BETTER GEARS WE MAKE!

Unusual stamina and precision are qualities inherent in all G. S. Gears. Whether made to transmit the power of a rugged outboard motor or give the dependability so necessary to a vital electronic instrument, G. S. Gearing *never lets you down!* Our fast growing list of critical customers is convincing evidence of the extreme durability and uniform accuracy of these better Gears. You'll profit too, by coming to "SMALL GEAR HEADQUARTERS" for all of your needs.

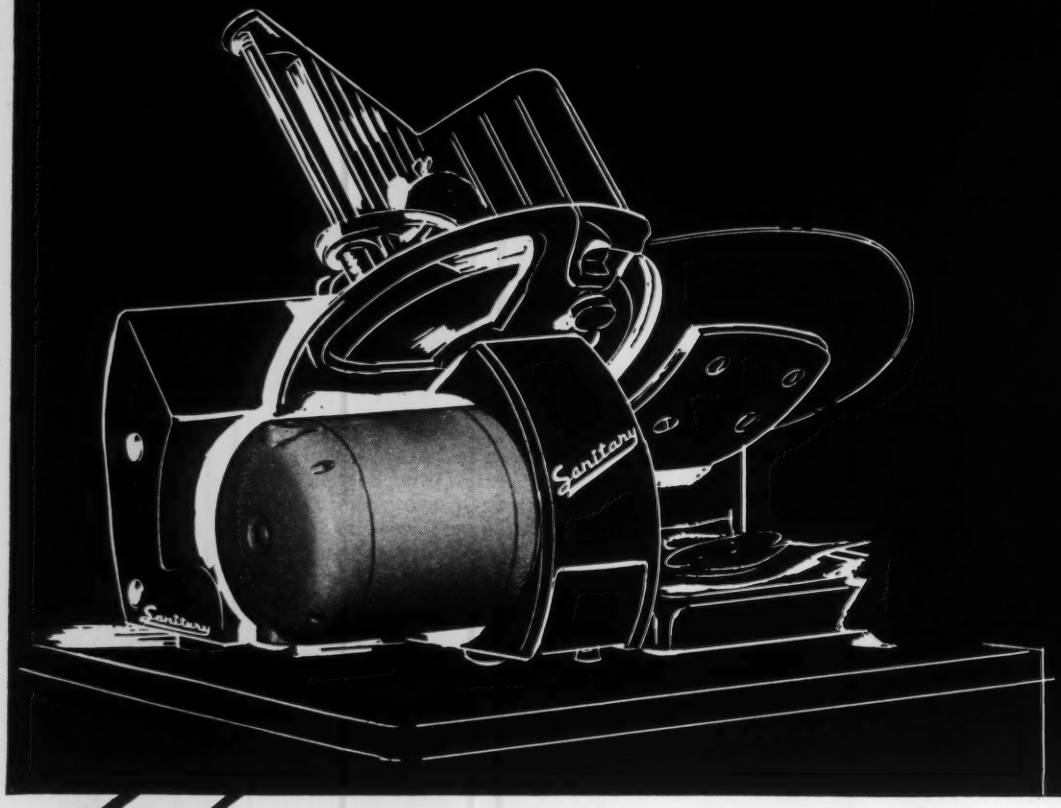
GET OUR *Free* 6-PAGE FOLDER

See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. This attractively printed 8½ x 11" 6-page folder is punched for ring-binder use. You'll want to keep it handy for frequent reference. It contains 23 pictures of Small Gears, plant views, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

HOW JACK & HEINTZ BUILDS MOTORS

HERE WAS THE PROBLEM

This is a typical J&H *Customized* Motor that powers the well-known Sanitary Scale Food Slicer. Attractive and efficient, it was styled for this application, complementing the food slicer in every detail. The motor requirements called for low noise level, complete freedom from vibration, special high thrust provision with minimum shaft end play and a rigid face-mounted end bell. The motor was totally enclosed to meet rigid sanitation requirements.

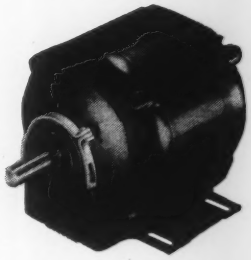


Customized JACK & HEINTZ

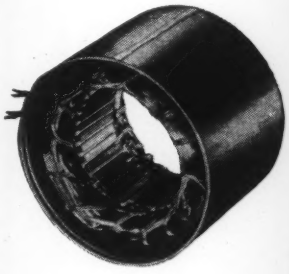
TO FIT THE *Sanitary* SLICER

J & H CUSTOMIZED MOTORS ARE DEVELOPED FROM STANDARDS

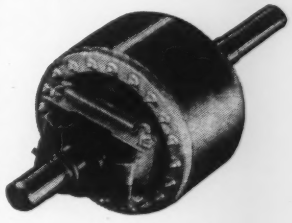
In custom designing a motor for an original equipment manufacturer, J&H engineers start with a basic motor. This is the step-by-step story, from one end bell to the other, of the evolution of a J&H *Customized* Motor.



A new cast-iron, face-mounted end bell features machined pilots for holding tolerances required for Sanitary's gear reduction drive.



Special low flux-density winding for extremely low noise level used in this heavy-gauge stator ring assembly.



A special shaft machined to Sanitary's requirements is assembled to a rotor core. Thrust assembly assures limited end play.

Selected for streamlined contours, this switch end bell facilitates ease of cleaning, further accentuates smooth lines of entire motor.

Here is the result—a *Customized* Motor with eye appeal, incorporating electrical and mechanical features designed to make it an integral part of Sanitary Scale's attractive slicer.

Design your product to do a job . . .

not to fit a motor

Avoid those "standard" motor compromises in your product through an engineering philosophy that's geared to solve your special needs. *Design your product to do a job . . . not to fit a motor!* Write Jack & Heintz, Inc., 17626 Broadway, Cleveland 1, Ohio.

©1954, Jack & Heintz, Inc.

ELECTRIC MOTORS J&H

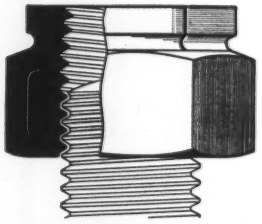
More and more automotive repair shops and industrial plants are turning to FLEXLOCs to reduce maintenance on high speed, vibrating equipment.

FLEXLOC locknuts save $600 per year in reconditioning automobile engines

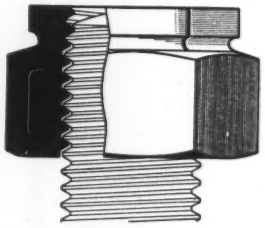
By using FLEXLOCs on connecting rod bolts, a motor reconditioning shop cut assembly time by a minimum of 5 minutes per motor. This added up to a yearly saving of 250 hours or $600. No drilling of bolts was needed . . . no adjusting of nuts to set cotter pins was required. And the FLEXLOCs assured a tighter assembly than was possible with the castellated nuts and cotter pins formerly used.

FLEXLOC locknuts reduce maintenance too. Once they are installed, you can forget them. Service and inspection periods can be stretched safely from days to weeks. And FLEXLOCs are reusable. They can be applied again and again without losing locking efficiency.

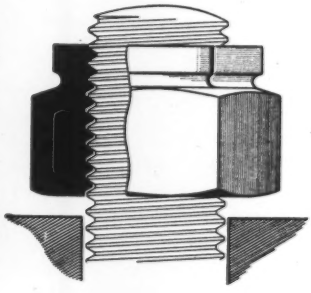
You can get FLEXLOC Self-Locking Nuts of various types and materials in a wide range of sizes and in any quantity. These one-piece, all-metal nuts are carried in stock by leading industrial distributors everywhere. Write for literature and samples for test purposes. STANDARD PRESSED STEEL Co., Jenkintown 18, Pa.



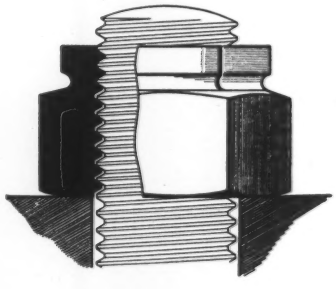
Starting. A FLEXLOC starts like any ordinary nut. Put it on with your fingers. Tighten it with a standard hand or speed wrench.



Beginning to Lock. As the bolt enters the segmented locking section, the section is expanded, and the nut starts to lock.



Fully Locked As a Stop Nut. When 1½ threads of a standard bolt are past the top of the nut, the FLEXLOC is fully locked. A FLEXLOC does not have to seat to lock.



Fully Locked As a Seated Nut. When it is used as a lock or stop nut, the locking threads of the FLEXLOC press inward against the bolt, lifting the nut upward and causing the remaining threads to bear against the lower surface of the bolt threads. Vibration will not loosen a FLEXLOC, yet there is no galling of threads.

FLEXLOC® LOCKNUT DIVISION

SPS
JENKINTOWN PENNSYLVANIA

DESIGN and PRODUCTION NEWS

FOR PLASTICS AND MATERIALS ENGINEERS

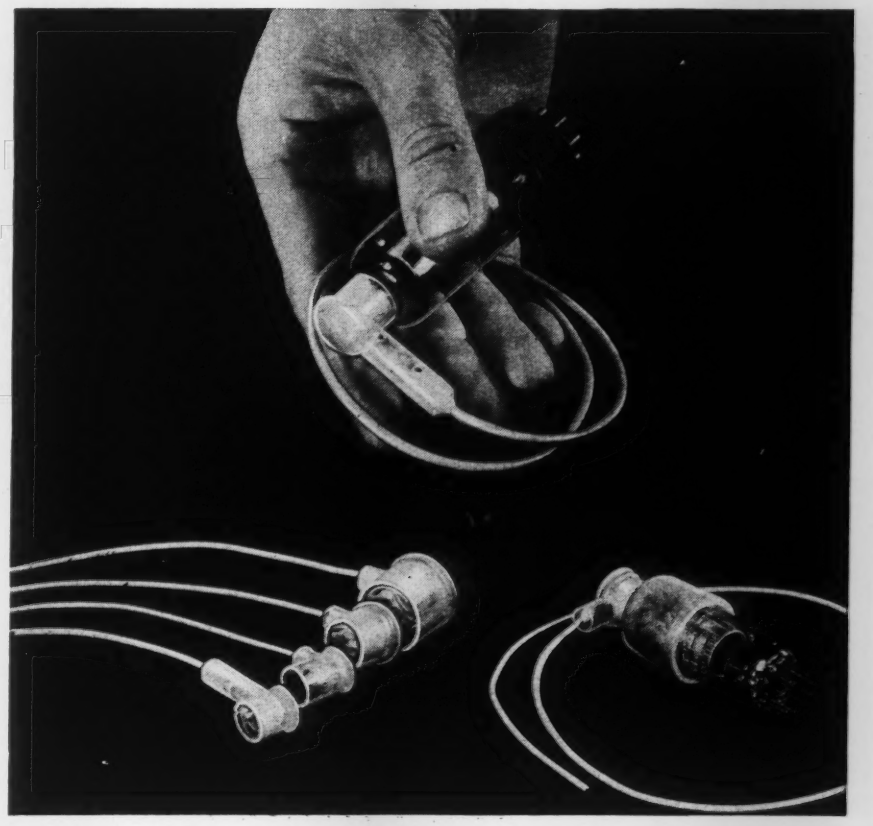
Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company JUNE-JULY 1954

New Cap Connectors of KEL-F® Polymer Widen Tube Service Range!

Exceptional moldability of KEL-F polymer and special equipment permit the "insert" molding of grid cap leads and resistors into a one piece insulated jacket. Conventional wire holes are eliminated, preventing insulation "pull back". Zero moisture absorption of KEL-F polymer and the elimination of wire holes precludes moisture collection which formerly caused "arc over" under high humidity.

The high insulation resistance and dimensional stability of KEL-F polymer over a wide temperature range (minus 320°F to plus 390°F) permits use of these connectors in critical installations subjected to extremes of temperature.

Alden Products Company, Brockton, Mass., uses KEL-F trifluorochloroethylene and a special molding technique to produce an entire series of connectors. Variety includes top- or side-connected leads, with or without resistors.



For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

CHEMICAL MANUFACTURING DIVISION

M. W. KELLOGG

KELLOGG PULLMAN

New Lower Prices for "Kel-F" Polymers Open Up Many New Applications Possibilities!

This is the fourth important price reduction since the introduction of KEL-F polymer products in 1948. It cuts prices up to 25% in ton lots, and as much as 42% for small quantities nominally used for experimental work.

The reduction is made possible by the rapidly expanding acceptance of KEL-F polymers and the manufacturing economies achieved in Kellogg's new production facilities. The reduced prices will greatly widen use for KEL-F polymers.

NEW PRICE SCHEDULE—Effective May 17, 1954

	High Density	Low Density	Plasticized
1-99 pounds	$10.00	$9.50	$11.00
100-1999 pounds	9.50	9.00	10.50
2000 pounds and over	9.00	8.50	10.00

® *Registered trade-mark for The M. W. Kellogg Company's fluorocarbon Polymers.*

KEL-F TRIFLUORO CHLORO ETHYLENE POLYMERS

KEL-F MOLDING POWDERS

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Need pins, pivots, mandrels, or other small parts? Need them in fine micro-finishes and tolerances in tenths . . . in special sizes and types to fit your product designs?

Torrington produces a wide variety of parts to customers' exact specifications . . . *faster, better and for less* than you can make them in your own plant. Why not let Torrington apply their many years of experience to *your* problems and have their special automatic machinery work for you?

Send for our Condensed Catalog. It shows many more of the parts we can produce economically for you. And send us a sample part or blueprint for our quotation—it can save you money.

THE TORRINGTON COMPANY
Specialties Division
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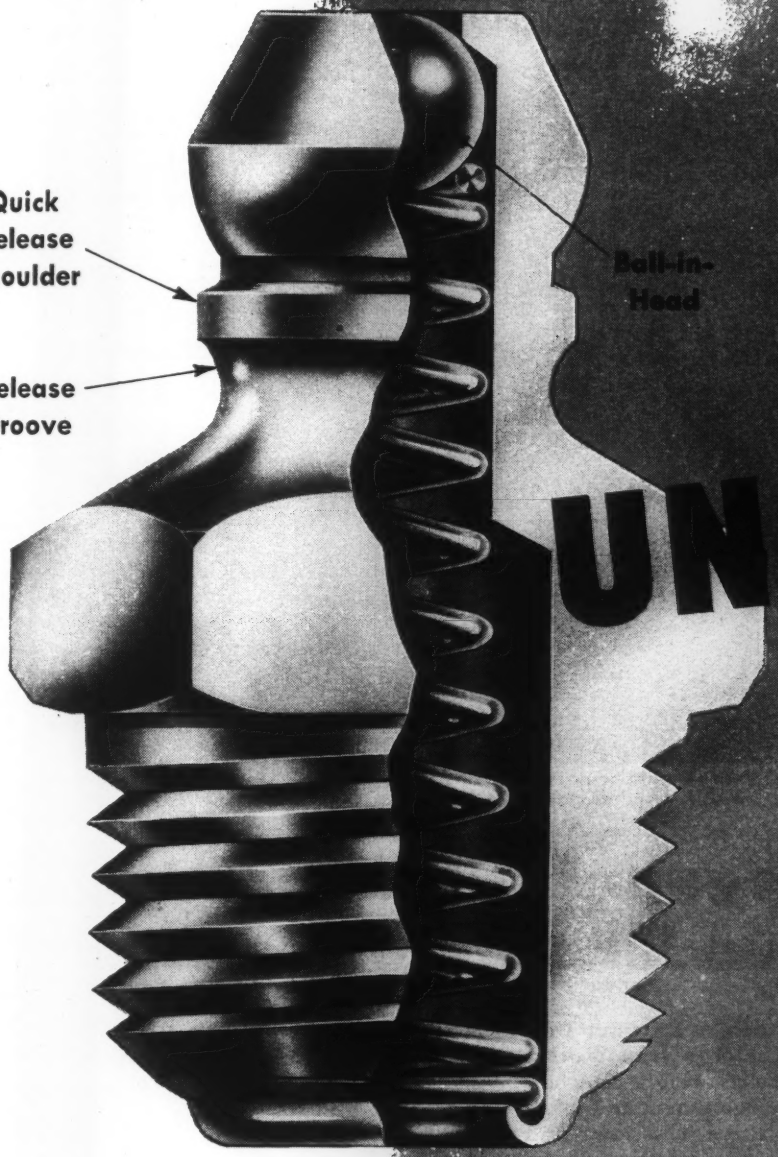
TORRINGTON *SPECIAL* **METAL PARTS**

Makers of Torrington Needle Bearings

There's All the Difference in the World in Grease Fittings!



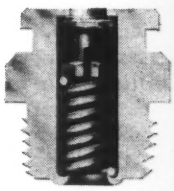
UNIVERSAL

Even in a part as small as a grease fitting, mechanical differences can result in big advantages in longer and better operating life for moving parts. Specifically:

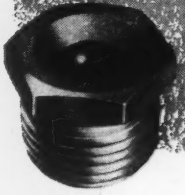
- Universal's patented *quick-release shoulder* unlocks coupler jaws quickly and easily —prevents twist-offs, distortion, breakoffs —prevents jaws from sliding down on neck of fitting.
- Patented *Release Groove* permits nose of coupler to clear fitting without binding.
- *Ball-in-Head* design seals out dirt, seals in grease.

Look closely at the advantages of Universal's different design before you specify grease fittings again. Details on the complete line of Universal fittings and lubrication accessories are available in catalog form. Use the coupon below.

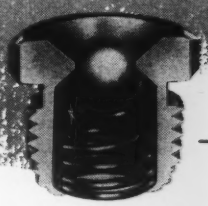
Streamlined One-Piece Design



Giant Button-Head Fitting, Plug Check



Streamlined One-piece Design



Giant Flush-Type Fitting, Ball Check

UNIVERSAL LUBRICATING SYSTEMS, INC.

780 Allegheny Ave., Oakmont, Pa.

Universal Lubricating Systems, Inc.
780 Allegheny Ave.
Oakmont, Pa.

Gentlemen:
Please send us, without obligation, a copy of your catalog.

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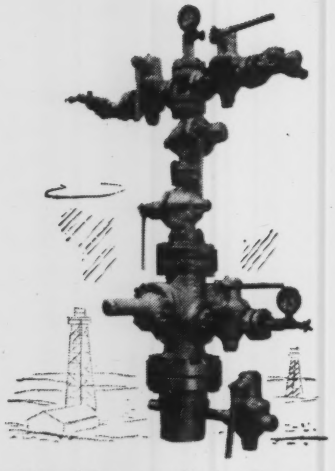
Goetze V-Tite Gasket being installed on flange of new Space Saver Blowout Preventer, designed and manufactured by Cameron Iron Works, Inc., Houston, Texas.

Goetze Gaskets safeguard critical points under severe pressures



Christmas Tree made by Cameron Iron Works, Inc., is equipped with Goetze V-Tite gaskets to provide safe, tight sealing for every joint.

The new "Space Saver" Blowout Preventer made by Cameron Iron Works, Inc., of Houston, Texas, weighs only half as much as earlier equipment and takes only one-half the space. This improved design permits rig platforms to be smaller, makes possible savings on handling and materials.

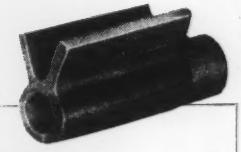
For this new equipment Cameron chose Goetze V-Tite Gaskets to do the critical job of sealing Ring-Joint flanges. These precision-made gaskets withstand the high pressures encountered in oil and gas production. Goetze V-Tite Gaskets are fabricated to extremely close tolerances to secure perfect matching of rings with flange joints. They are carefully heat-treated to keep hardness below the maximum allowable. This assures proper flow of the gasket without damage to flange surfaces and reduces the necessity for undue bolt stresses.

Both standard cross-sectional shapes, the oval (Style 950) and octagonal (Style 951), seal tightly at low bolt stresses. Made to ASA-API standards, they are supplied in metals and alloys offering maximum resistance to service and temperature conditions. In addition to the ASA-API sizes, special sizes ranging from one inch to seven feet pitch diameter are available. Catalog PK-35A gives details, sizes and engineering data. Write for it to Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville GOETZE GASKETS

ACCUMET PRECISION INVESTMENT CASTINGS



are available in all steel and high-alloy grades...

Whatever the grade of steel or high-alloys your specifications call for, you can get it in Crucible ACCUMET® precision castings.

And you can depend on the quality of ACCUMET castings, for they are made by the Country's leading specialty steel producer . . . to long established steelmaker's melting standards, in modern electric furnaces. The composition of ACCUMET is carefully controlled by chemical analysis of the *casting* — not merely of the remelt stock charged into the furnace. This extra control of analysis means better uniformity in response to heat treatment, hardenability and performance.

Put an end to costly machining of parts. Let your Crucible representative show you how ACCUMET precision investment castings can save you time and money.

Here are some of the more popular grades used for Crucible ACCUMET precision castings

AISI 1010 — Magnetic Iron
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Mod. 4140 — Medium to High Tensile
Ketos Oil-Hardening Tool Steel
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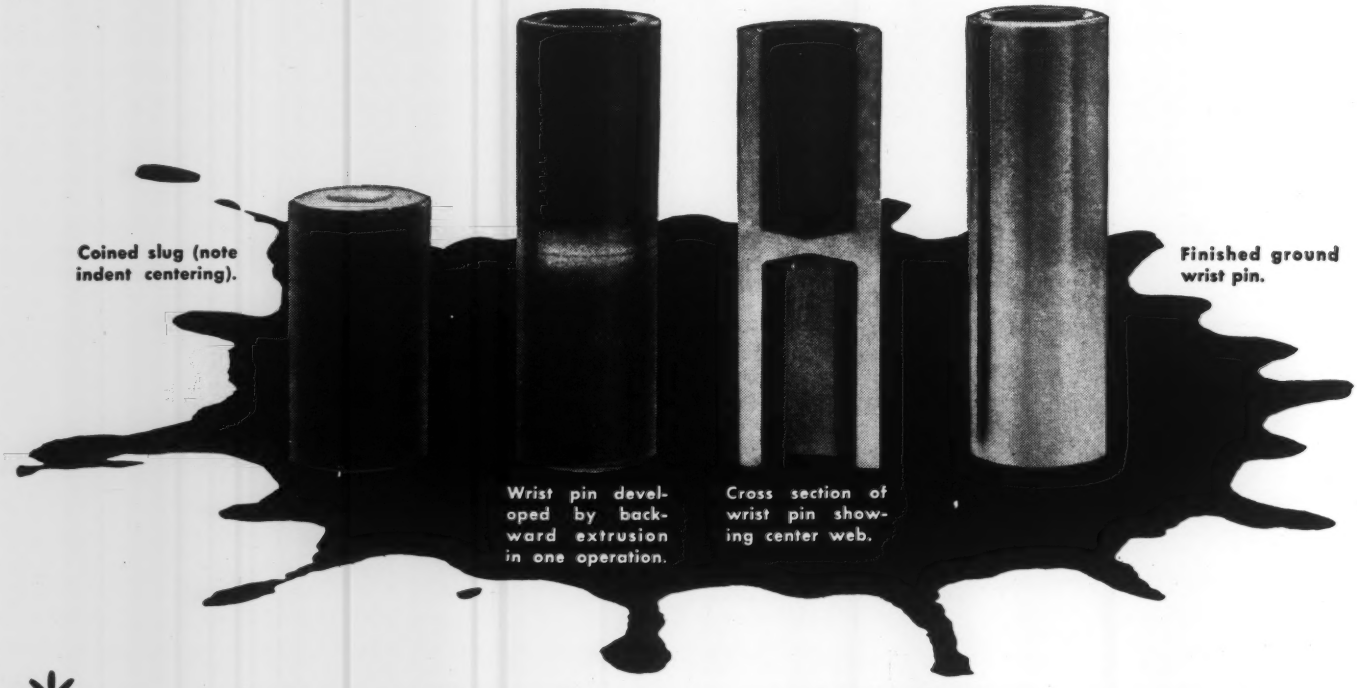


*as a separating layer and lubricant carrier is the key to the success of COLD FORMING

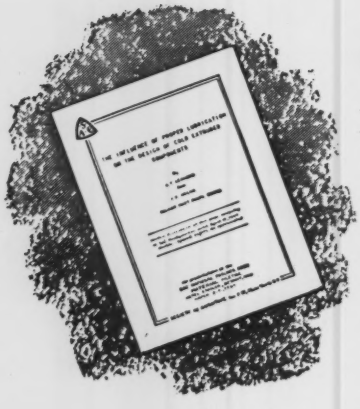
Present day deep draws and cold extrusions were labeled "impossible" just a few years ago. Tool design, production techniques and lubrication have improved. Especially lubrication.

Treatment with Bonderite and Bonderlube has been the key to successful production of extruded parts large and small.

Investigate extrusion, using Bonderite and Bonderlube. Get savings through less expensive raw materials, reduction of scrap, improved physicals, less machining, reduced operations.

Draw on Parker's unique store of knowledge and experience in extrusion. Call in the Parker representative.

**Bonderite, Bonderlube, Parco, Parco Lubrite—Reg. U.S. Pat. Off.*



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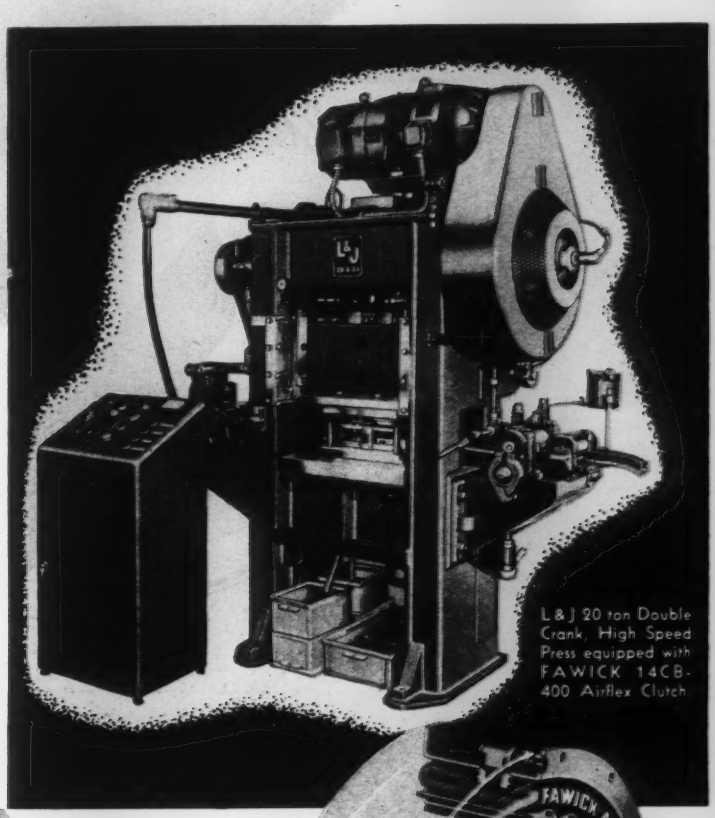

L & J 20 ton Double Crank, High Speed Press equipped with FAWICK 14CB-400 Airflex Clutch

Increased Production

FAWICK Airflex Clutches, through fast dependable action, increase machine cyclic operating speeds. They transmit FULL power to the work through 360° application of operating pressure at the maximum effective diameter—with split-second response from local or remote controls.

Added Safety

FAWICK units absorb load and operating shocks through the cord and rubber actuating tube. This provides maximum protection to all machine parts, adding greatly to machine and die life while reducing operator fatigue.

Low Maintenance

FAWICK Clutches practically eliminate clutch maintenance costs, as they require no lubrication or linkage adjustment. FAWICK units maintain "new clutch" operation and dependability throughout an exceptionally long service life, as they automatically adjust for operating wear.

Adaptability

FAWICK Airflex Clutches are easily adaptable to either new or existing equipment. The simple compact design and operation of FAWICK units eliminate extensive engineering or alterations to convert new or existing equipment to higher operating efficiency. FAWICK Engineering Service is available without obligation.

Fawick Type CB Airflex Clutch

For further information on Fawick Industrial Clutch and Brake Units, write to the Main Office, Cleveland, Ohio for Bulletin 400-A.

FAWICK AIRFLEX DIVISION
FEDERAL FAWICK CORPORATION
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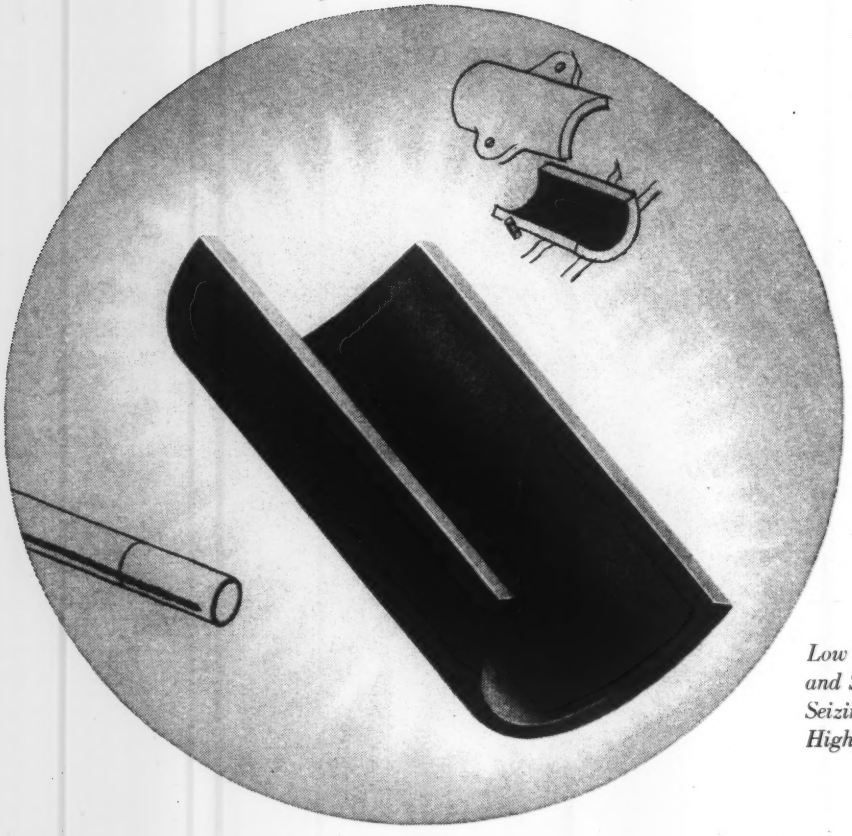
FAWICK Airflex

INDUSTRIAL CLUTCHES AND BRAKES



Low Friction Bushings and Sleeves Resist Seizing, Abrasion, High Temperatures

HAYNES STELLITE Bushings and Sleeves

Trade-Mark

...for handling Hot-Abrasive Materials

Bearing parts made of HAYNES STELLITE alloy resist seizing and galling. They are hard and abrasion resistant, and will withstand the pitting effects of many corrosives. They take a high polish and are easy to apply. Use them to reclaim worn shafts or bearing blocks, and to lengthen the life of new equipment.

Operate with Little or No Lubrication

Sleeves made of HAYNES STELLITE alloy can be used in areas where efficient lubrication is impossible. They resist seizing even when lubricants are diluted by gasoline, cleaning fluids, and other liquids that wash out an oil film. They operate at peak efficiency even when lubricants decompose under heat, or are destroyed by abrasive particles.

Tough and Abrasion-Resistant

Bearing parts made of HAYNES STELLITE alloy resist the abrasive effects of wet or dry materials such as fly ash, coke, metal powder, shale, and cement dust. They are hard enough to carry heavy loads, and tough enough to stand up under repeated stress.

Heat and Corrosion Resistant

These bushings and sleeves can be submerged in many acids, alkalies, and molten metals. Temperatures as high as 1500 deg. F. have little effect on their hardness, toughness, and dimensional stability.

For more information write for our 8 page booklet on half bushings and sleeves.

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HAYNES STELLITE COMPANY

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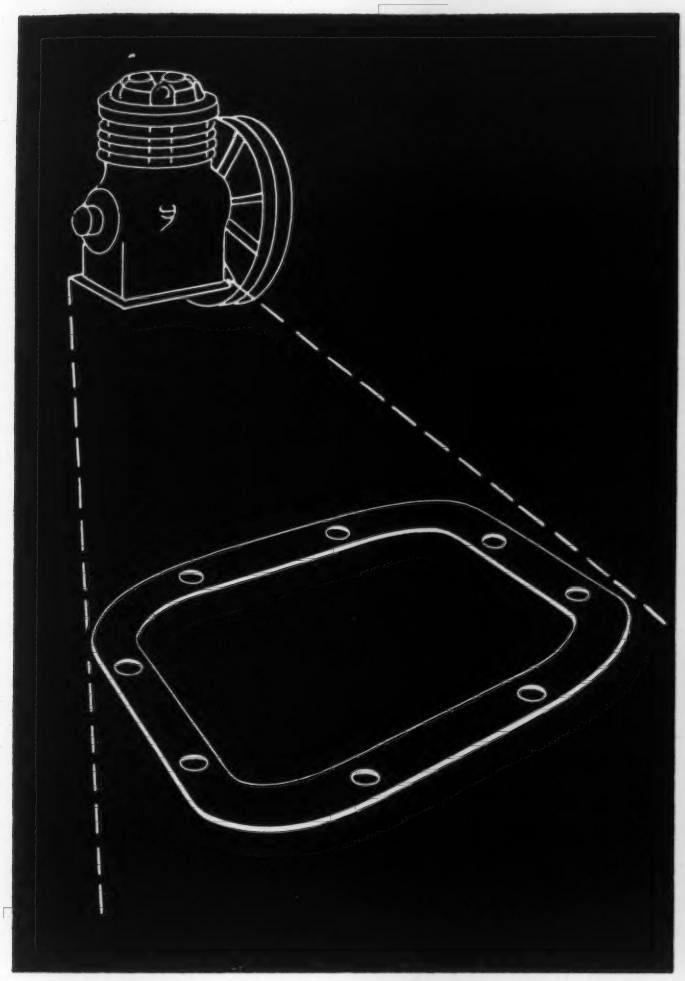
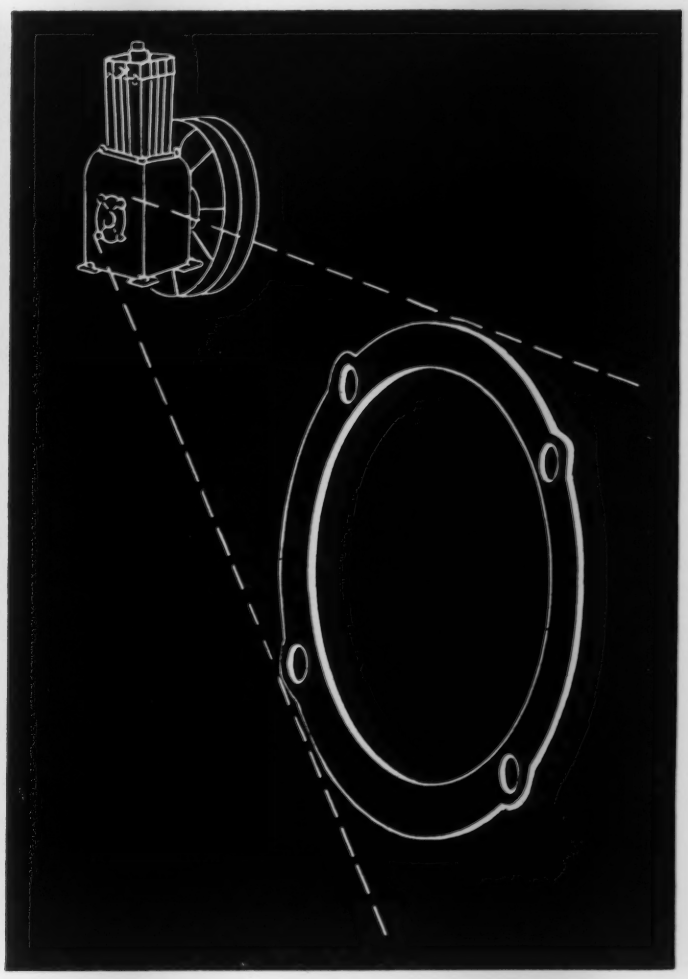




No oil leakage with this new, non-shrinking fiber gasket

Leaky gaskets don't always interfere directly with an air compressor's operation, but they do bring in a lot of complaints. One compressor manufacturer had exactly this trouble with oil pan and bearing carrier gaskets made from a conventional fiber sheet. Oil and oil vapors leached out the binder, causing the gaskets to dry out, shrink, and leak.

He found an effective, economical solution by changing to an entirely new kind of fiber gasketing —Armstrong's Accopac®. Accopac is a beater-saturated material made with a non-extractable rubber latex binder. It *can't* dry out, shrink, or harden in any recommended application.

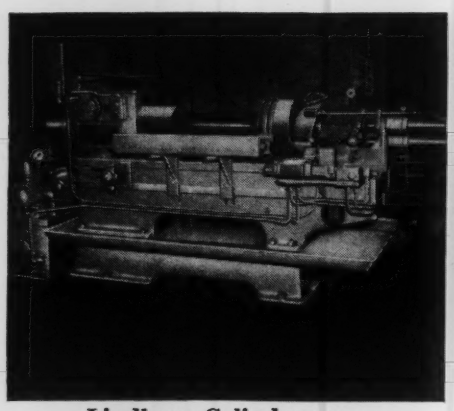
Accopac CN-705 gaskets are now specified on these compressors, improving their appearance on the job, reducing customers' cleaning and maintenance costs, and cutting down complaints greatly.

WON'T SHRINK OR DRY OUT. Accopac gives good results in this kind of service because of the way it's made. Fiber, cork, and rubber are literally locked together by a patented beater saturation method which makes each sheet uniformly strong and homogeneous. Thus, Accopac gaskets are impervious and remarkably resistant to dimensional change. Even after months of storage, they fit and seal perfectly.

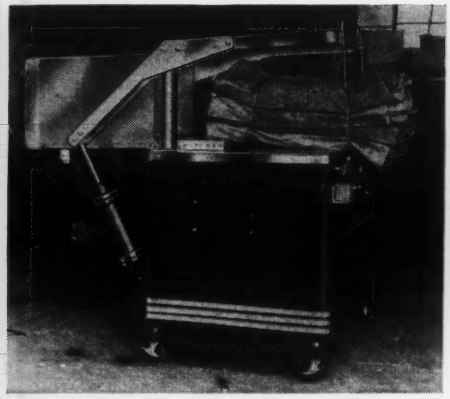
WIDE RANGE OF APPLICATIONS. Wherever dependable, low-cost sealing is required, Accopac has found ready acceptance. It's being used today in pumps, engines, aircraft and automotive equipment, household appliances, and in an ever-increasing variety of similar applications.

FREE 1954 GASKET MANUAL—For full information on Accopac and other versatile gasket materials, write for the 24-page manual, "Armstrong's Gasket Materials." It contains latest information on specifications, plus data on cost reduction, gasket tolerances, flange and joint design, etc. See it in Sweet's product design file, section 3h or write Armstrong Cork Co., Industrial Div., 7006 Dean Street, Lancaster, Penna.

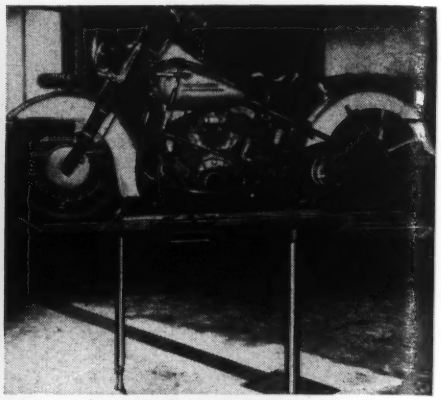
ARMSTRONG'S ACCOPAC



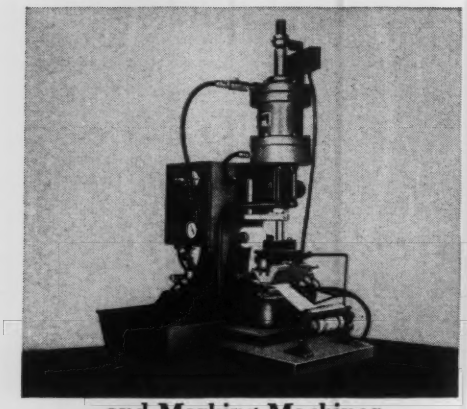
Lindberg Cylinders are used on Machine Tools



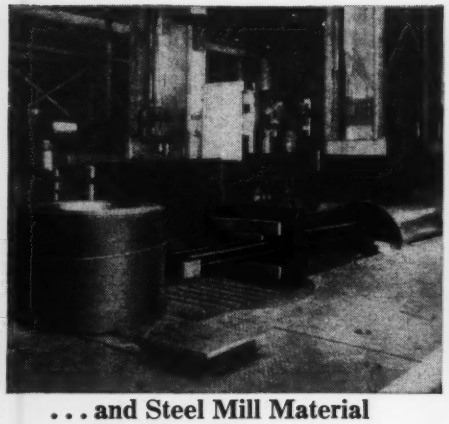
. . . and Clamping Machines



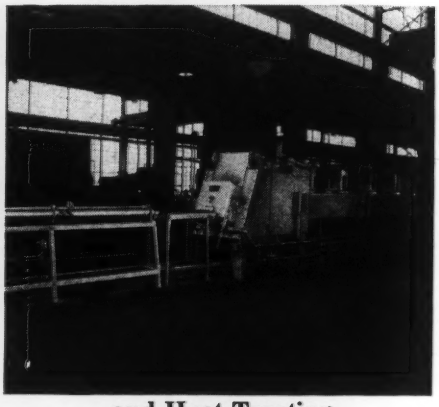
. . . and Material Lifting Equipment



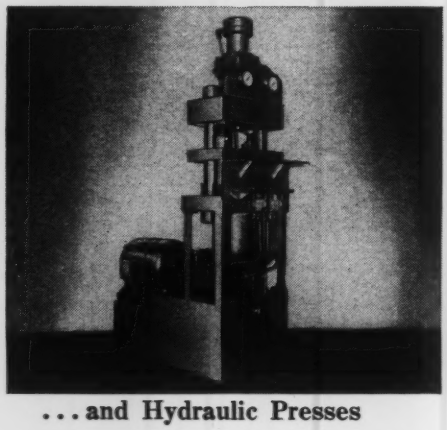
. . . and Marking Machines



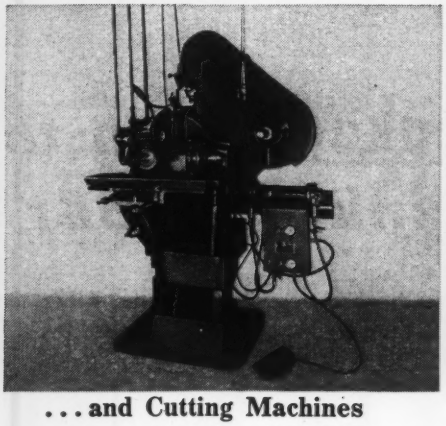
. . . and Steel Mill Material Handling Equipment



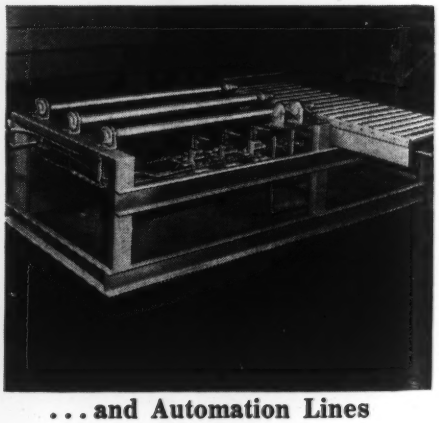
. . . and Heat Treating Furnaces



. . . and Hydraulic Presses



. . . and Cutting Machines



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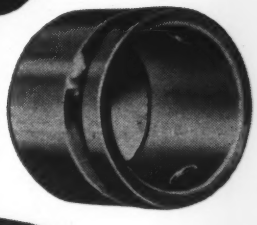

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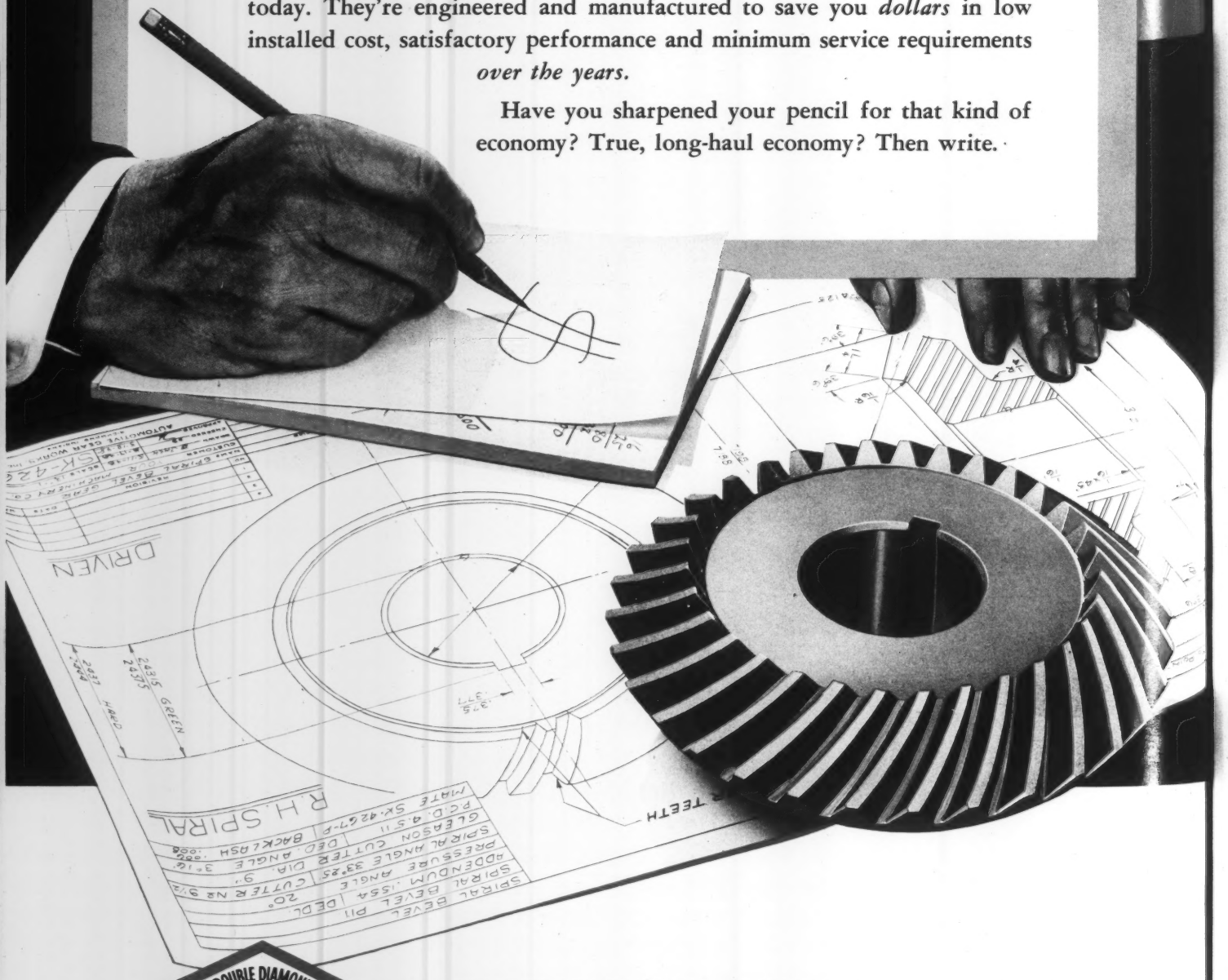
Frankly, "Double Diamond" Gears aren't built to save you a few pennies today. They're engineered and manufactured to save you *dollars* in low installed cost, satisfactory performance and minimum service requirements *over the years.*

Have you sharpened your pencil for that kind of economy? True, long-haul economy? Then write.



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JUNE 1954

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12	58	99	224	265	305	335	BL362
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14	60	101	226	267	307	B336	T363
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19	64	173	230	271	311	340	TR364
20	65	175	231	272	312	341	BL364
21	66-67	177	232	273	313	342	BR364
22	68	178	233	274-5	314	343	R365
23	69	181	234	276	315	344	TL365
24	70	183	235	277	316	345	BL365
25	71	185	236	278	317	346	TL366
26	72	186	237	279	T318	347	TR366
27	73	189	238	280	B318	348	BL366
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29	75	193	240	282	L320	350	T367
30	76	195	241	283	R320	351	BR367
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37	82	204	247	288	L324	TL358	BL369
38-39	83	205	248	289	R324	TR358	TR371
40	84	206-7	249	290-1	325	BL358	TL371
41	85	208-9	250	292	T326	BR358	BR371
42-43	86	210-11	251	293	B326	R359	373
44	87	212	252	294	327	TL359	376
45	88	213	253	295	L328	BL359	IBC
46-47	89	214	254	296	R328	TL360	OBC
48							

PLEASE SEND further information on the advertisements appearing on the pages which are circled above.

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Further Information?

If you would like further information on any of the ADVERTISEMENTS in this issue, circle the page numbers of these items on one of the cards below Then fill in your name and address and mail to us. Your requests will be forwarded to the companies concerned, the answers coming direct to you. When more than one advertisement appears on a page, the following code will be used for identification: T—Top, B—Bottom, L—Left, R—Right (IFC—Inside Front Cover. IBC—Inside Back Cover. OBC—Outside Back Cover)

- For extra copies of editorial articles, use EDITORIAL REQUEST CARDS—page 170
- For further information on New Parts and Equipment, Engineering Department Equipment, and Helpful Literature, use HELPFUL LITERATURE REQUEST CARDS—p. 187

JUNE 1954

IFC	49	90	215	255	297	329	TR360
1	50	91	216	256	298	T330	BL360
2	51	92-93	217	257	299	B330	BR360
5	52	94	218-9	259	300	331	R361
6	53	95	220	261	301	332	TL361
8	54-55	96	221	262	302	333	BL361
9	56	97	222	263	303	L334	TL362
11	57	98	223	264	304	R334	TR362
12	58	99	224	265	305	335	BL362
13	59	100	225	266	306	T336	BR362
14	60	101	226	267	307	B336	T363
15	61	103	227	268	308	337	BR363
16-17	62	105	228	269	309	338	BL363
18	63	106	229	270	310	339	TL364
19	64	173	230	271	311	340	TR364
20	65	175	231	272	312	341	BL364
21	66-67	177	232	273	313	342	BR364
22	68	178	233	274-5	314	343	R365
23	69	181	234	276	315	344	TL365
24	70	183	235	277	316	345	BL365
25	71	185	236	278	317	346	TL366
26	72	186	237	279	T318	347	TR366
27	73	189	238	280	B318	348	BL366
28	74	191	239	281	319	349	BR366
29	75	193	240	282	L320	350	T367
30	76	195	241	283	R320	351	BR367
31	77	197	242-3	284	321	352	BL367
32	78	199	244	285	T322	353	TR368
33	79	201	245	286	B322	355	BR368
34	80-81	202-3	246	287	323	356	TL369
37	82	204	247	288	L324	TL358	BL369
38-39	83	205	248	289	R324	TR358	TR371
40	84	206-7	249	290-1	325	BL358	TL371
41	85	208-9	250	292	T326	BR358	BR371
42-43	86	210-11	251	293	B326	R359	373
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Cleveland, Ohio

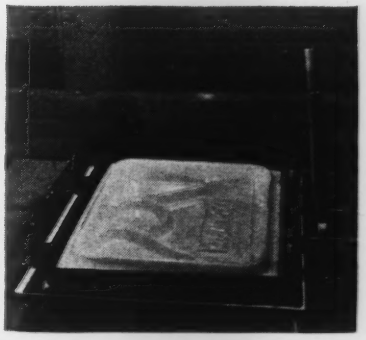
PLASTICS PROGRESS

How to get better... lower-cost products with *plastics!*

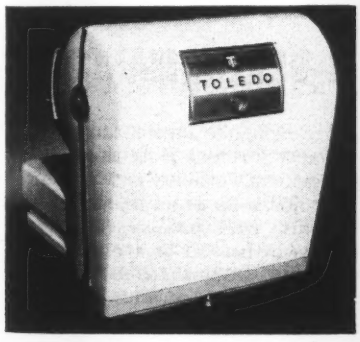
CLEAR ACRYLIC MOLDED PARTS— WITHOUT ANNEALING

If molders tell you methyl methacrylate can't be molded stress-free and clear without costly annealing . . . come to us. We've developed a new technique that produces large acrylic parts in one molding operation without annealing. And they're more clear than glass! The container from Ebco's Fruit Juice Dispenser shown above is a good example. It is free from strain and internal stress even though it is 12″x13″x9″ high. Don't pass up the eye appeal and the buy appeal of clear acrylic—come talk to us.

CAMPCO S-300—THE NEWEST DEVELOPMENT IN PLASTIC MATERIALS



Campco S-300 is a formable, rigid rubber styrene sheet that can be shaped in a matter of seconds with inexpensive equipment and low-cost molds. The result is a product with the porcelainlike finish of molded polystyrene. Campco sheet is easily embossed or deep-drawn under heat. It can be printed, painted, laminated. Available in full range of translucent or opaque colors. Widths from 20″ to 58″. Thicknesses from .005″ to .125″, any desired length. See it formed on the spot with lowest cost tooling—Booth 128, National Plastics Exposition.



HOW TO MOLD LARGE PARTS FROM UREA PLASTIC

The picture shows the housing we molded for Toledo's new Guardian 70 scale. Not all molders can do it. Many won't even try. Why? It takes unusual engineering . . . tool designing . . . extra large presses . . . and years of experience in urea molding to do the job right. Why not follow leaders of industry like Toledo—and come to us for results on tough jobs like this?

COMPLEX MOLDED PLASTIC FOR CROSLEY

According to Crosley, their "V.I.P." clock radio stands for "very important product for very important people." It also means "Very Intricate Production." Look inside the housing . . . you'll see why! We had to design an opposed plunger mold to produce the main housing . . . large movable cores for the control and speaker openings on three sides. Base forms a 3-way sound chamber. With undercuts, flanges, bosses, slots and side openings, it took mighty close tolerances. We do it all the time.

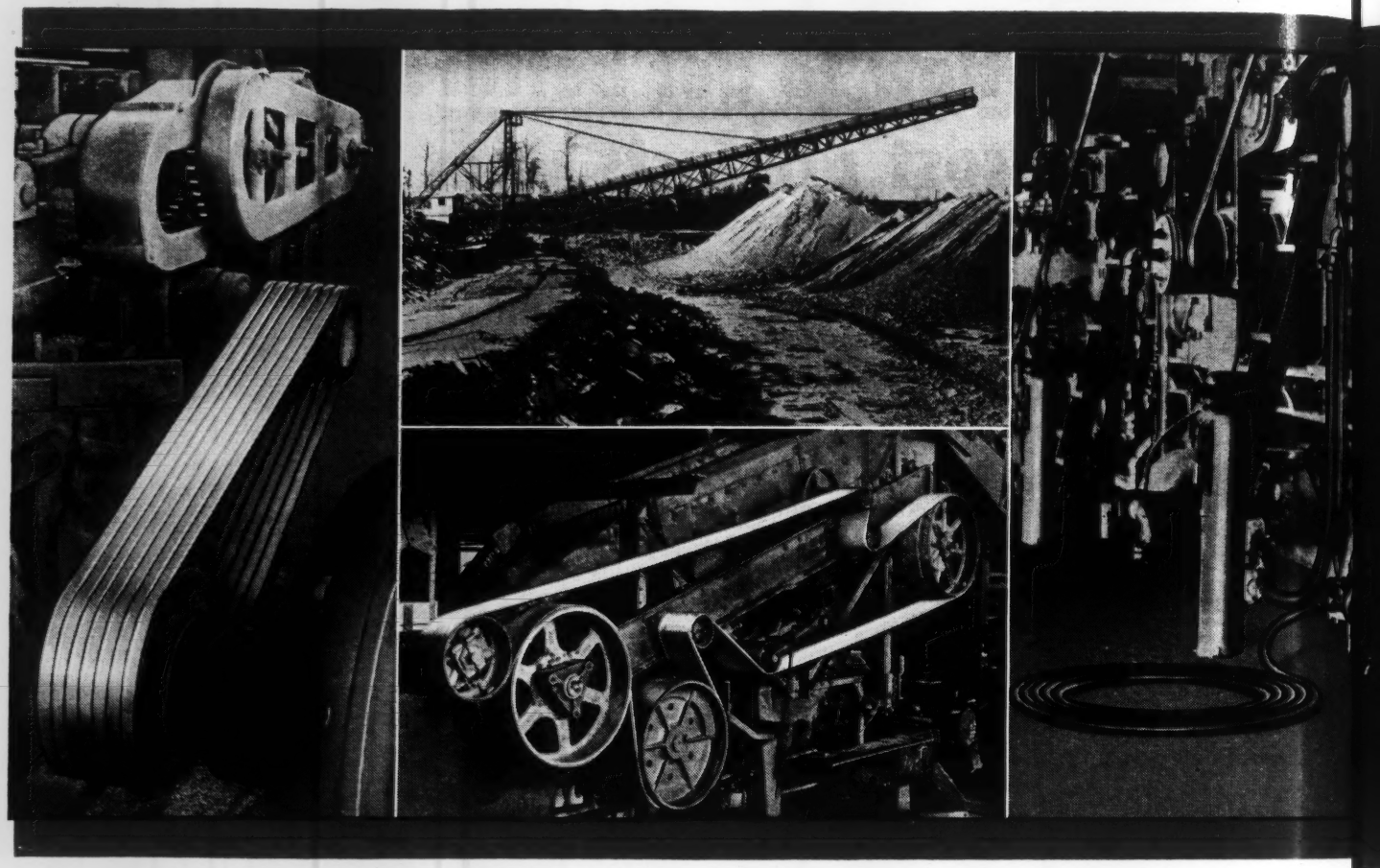
NYLON MOLDINGS: Chicago Molded nylon parts provide unusual performance characteristics . . . from electric shaver cams to valve bodies. Ask us for the facts on your application.

CHICAGO MOLDED PRODUCTS CORPORATION

1028 North Kolmar Avenue, Chicago 51, Ill.

CUSTOM MOLDERS OF ALL *Plastics*

CALL ON R/M ENGINEERING SERVICE



R/M MECHANICAL RUBBER PRODUCTS FOR BETTER PERFORMANCE

Design engineers rely on R/M's 60 year experience, engineering and facilities for making mechanical rubber products that give better performance. For example, R/M Super-Power V-Belts have up to 40% greater horsepower capacity than regular V-belts. This means you can increase the horsepower of a drive with no change in drive design . . . or save space by using fewer belts to meet horsepower specifications. Where flat belts are required, as on the portable crusher and screen shown above, Condor Whipcord Endless Belts have been known to outlast up to 10 ordinary belts. R/M offers a complete selection of belts and driving surfaces from low-tension to desired slip for every flat belt drive requirement.

There is also an R/M engineered conveyor belt for every application, such as the traveling stacker conveyor pictured above . . . for heavier quarry and mining operations . . . for lighter portable and package conveyors. R/M makes hose for hundreds of uses—from ¼" to sizes large enough to crawl through. Typically, the Homoflex Paper Machine Hose shown was designed for strength, extreme flexibility and light weight, with a soft rubber nozzle to avoid injury to costly machine rolls. R/M also mass produces engineered molded rubber parts of natural or synthetic rubber, nylon or silicone, in any size or shape to meet your specifications. Let an R/M rubber specialist work with you on your next design project or to improve present performance.

For booklet shown, or other data, write, phone or wire:

MANHATTAN RUBBER DIVISION
Raybestos-Manhattan, Inc.
Passaic, N.J.
GRegory 3-2000

R/M

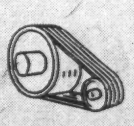
SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

Brake Blocks, Linings and Clutch Facings

Fan Belts and Radiator Hose

Mechanical Packings and Gaskets

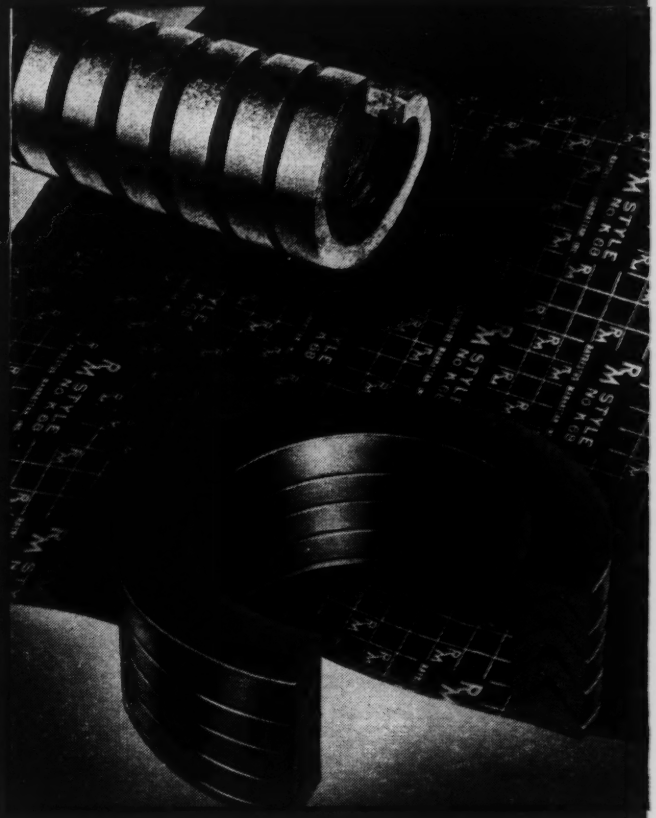
Abrasive and Diamond Wheels



Industrial Drive Belts

Industrial and Automotive Hose

FOR HELP IN SOLVING YOUR PROBLEMS



FRICTION MATERIALS

new 44-page bulletin just off press!

If you are looking for practical design and engineering data on friction materials you will want a copy of R/M's new and comprehensive Engineering Bulletin No. 500. Its contents are intended as a guide in the choice of friction materials and as an aid in the design of friction devices. Its 44 pages are crammed full of charts, diagrams and photographs. An outstanding feature, to pick just one, is a selection chart which gives complete design data for R/M friction materials operating in oil.

For R/M Bulletin No. 500, or other data, write, phone or wire:

EQUIPMENT SALES DIVISION
Raybestos-Manhattan, Inc.
6010 Northwest Highway
Chicago 31, Ill.
ROdney 3-2400

PACKINGS, GASKETS,

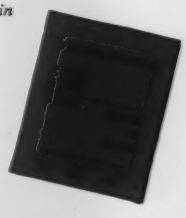
Asbestos Textiles and "TEFLON"* products

For specialized packing engineering service, call on Raybestos-Manhattan. R/M makes a complete line of packings and gasket sheets for use against air, gas, water, steam, oil, solvents, foods and hydraulic fluids. It also makes an unusual number of asbestos textiles and a wide variety of "TEFLON" products. The many years' experience R/M has had in these fields can be put to work for you at once. Just say the word. Send for booklet on packings, gaskets and "TEFLON" products.

**Du Pont's trade-mark for its tetrafluoroethylene resin*

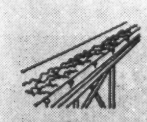
For booklet shown, or other data, write, phone or wire:

PACKING DIVISION OR ASBESTOS TEXTILE DIVISION
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

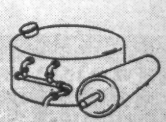


RAYBESTOS-MANHATTAN, INC.

FACTORIES: Passaic, N.J. • Neenah, Wis. • Manheim, Pa. • No. Charleston, S.C. • Crawfordsville, Ind. • Peterborough, Ontario, Canada



Conveyor Belts



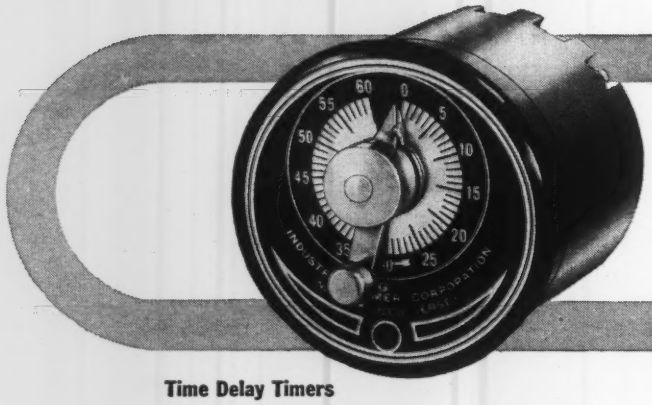
Rubber Lined and Covered Equipment

Sintered Metal Friction Elements

Asbestos Textiles

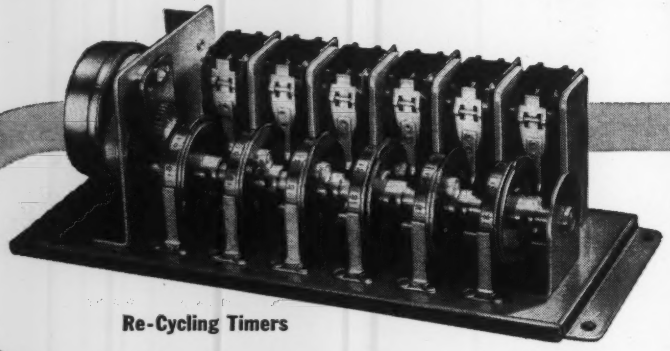
Teflon Tape, Packings, Sheets, Rods, Tubes

Engineered Molded Rubber and Plastics

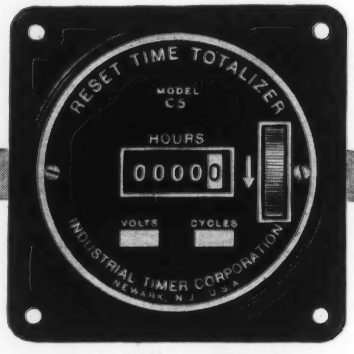


Time Delay Timers

Interval Timers



Re-Cycling Timers



Running Time Meters

MOST COMPLETE LINE OF INDUSTRIAL

TIMERS for automation

The individual requirements of each automation problem are best met by selecting timers designed to perform specific functions. Whatever your timing-control problem, Industrial Timer Corporation can meet it with one of its standard timers, a combination of its standard units, or by designing an entirely new timing element. Our Engineering Department not only originates new designs, but also develops modifications to meet our customers requirements.

We manufacture a complete line of timers in these 4 broad classifications:

TIME DELAY TIMERS • RE-CYCLING TIMERS
INTERVAL TIMERS • RUNNING TIME METERS

Our large stocks of 17 basic types from which we have developed over 660 combinations to date, enables us to make rapid deliveries in most cases . . . and excellent deliveries on special orders. Our automation timer specialists will be happy to discuss your automation timer requirements. Your inquiries will receive prompt attention.

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

INDUSTRIAL TIMER CORPORATION
131 OGDEN STREET, NEWARK 4, N. J.

Announcing . . . new 88-page
SILENT CHAIN DATA BOOK

Here's a complete, easy-to-use guide to efficient drive selection

THIS comprehensive book covers all phases of industrial silent chain drive application. Complete information is included on drive selection . . . chain and wheel specifications . . . casings, lubrication, installation and maintenance. Illustrated are the wide range of drive applications on which Link-Belt Silverstreak Silent Chain can save you money.

CLIP THIS COUPON AND MAIL TODAY

LINK-BELT

SILVERSTREAK SILENT CHAIN DRIVES

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.539

LINK-BELT COMPANY
220 S. Belmont Ave., Indianapolis 6, Ind.
(or your nearest Link-Belt office)

Please send a copy of your new Silent Chain Data Book No. 2425.

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Position .....

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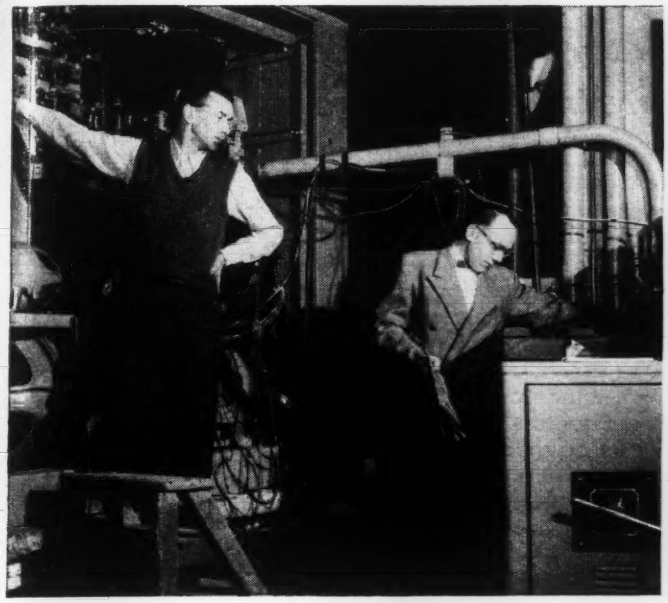
HERE IS THE MOST modern adjustable speed drive available today . . . the compact, G-E packaged speed variator: drive motors, power unit and operator's control station.

GENERAL ELECTRIC



COMPLETELY PRETESTED by G-E engineers in the factory, the packaged speed variator comes to you tailored to your job. Picture shows a power unit on one of the factory tests.

PACKAGED DESIGN of G-E speed variator simplifies installation, saves space and lessens your maintenance problems. Picture shows ready accessibility of all parts.

4 Good Reasons for Buying G-E PACKAGED Speed Variators

There's a ***difference*** among adjustable-speed drives; here's why the General Electric ***packaged*** speed variator is your best buy:

1—JOB-TAILORED. When your new G-E drive is delivered, it has already been tailored to your specifications. It's coordinated, packaged, assembled and ***completely tested*** before it leaves the G-E factory. It's been ***engineered*** as a package to help meet your needs.

2—MORE COMPACT. Because there are only three components to the G-E ***packaged*** speed variator (see opposite page), less space is needed for the complete installation. This cuts down on costly, interwiring problems, and leaves valuable floor space available. The G-E packaged speed variator is designed to be located near your equipment . . . up above, in a basement, right next to drive motor . . . anywhere you wish. No need for expensive control housing and associated ventilating system.

3—FASTER INSTALLATION. Your installation costs drop radically and your new G-E drive is in operation faster because it's packaged in the G-E factory before it's shipped to you. Long, unproductive work-stoppages are no longer necessary.

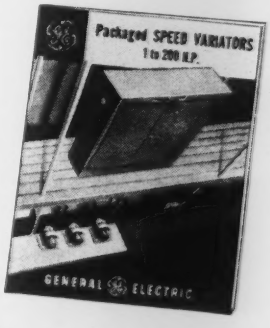
4—LESS MAINTENANCE. Your speed variator is made up of the standard, General Electric controls and rotating equipment that have proven their reliability and long life in many thousands of applications throughout industry. Because of these top-quality G-E components, maintenance is only a routine problem. And even ***routine*** maintenance is simplified because of the ready-access doors on the equipment. This packaged simplicity pays off in less downtime and actual dollar-savings in maintenance each year.

For further information, see your nearby G-E Apparatus Sales Office, or send in coupon. General Electric Company, Schenectady 5, N. Y.

Progress is our most important product

GENERAL ELECTRIC

Send coupon for your copy of new, 20-page bulletin (GEA-6127) on G-E packaged speed variators.



Section H822-1
General Electric Co.
Schenectady 5, N. Y.

Please send my copy of GEA-6127.

☐ **For reference purposes only.**
☐ **For immediate application.**

Name.....

Address.....

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City..... **State**.....

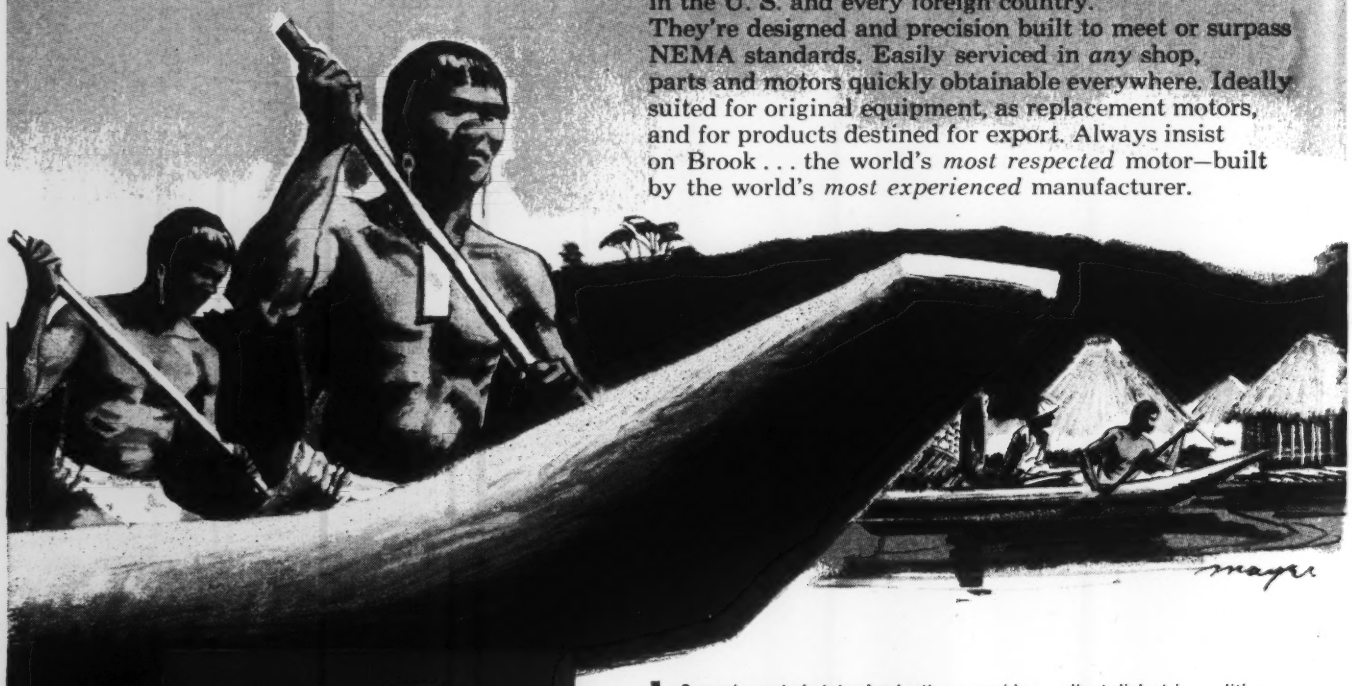
It beat the backwoods of

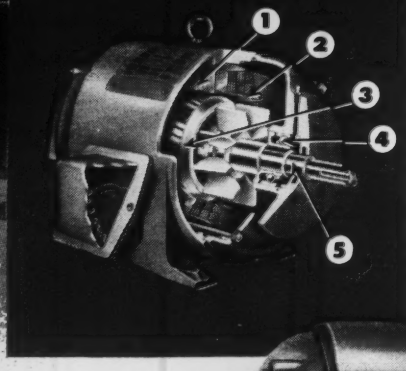
BRAZIL

...BROOK MOTORS can meet your operating requirements, too!

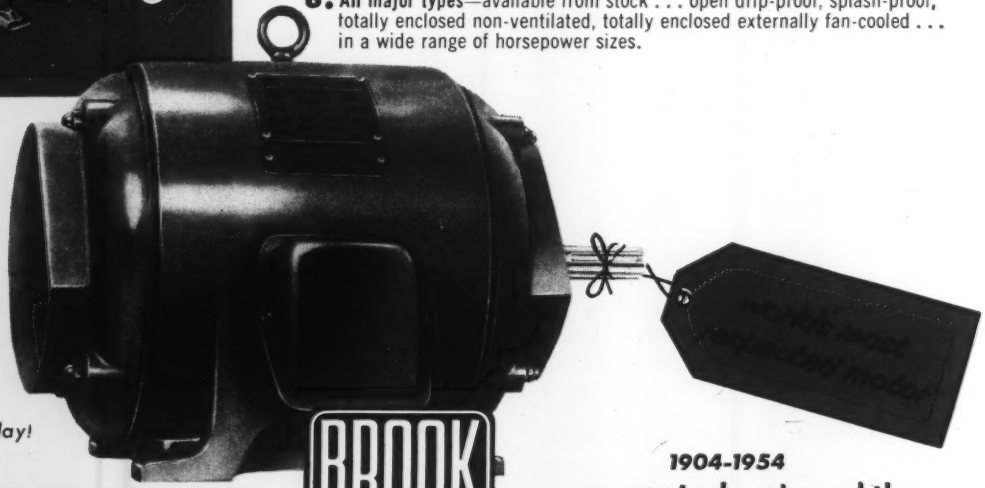
Wherever there's rough going—whether it's the most adverse climatic or temperature conditions, you can always count on Brook AC electric motors to give the most dependable service—anywhere in the world! Famous Brook motors are built with mica-insulated stator slots and windings that are impregnated and baked to resist the heat, cold, moisture and dust encountered in the U. S. and every foreign country.

They're designed and precision built to meet or surpass NEMA standards. Easily serviced in *any* shop, parts and motors quickly obtainable everywhere. Ideally suited for original equipment, as replacement motors, and for products destined for export. Always insist on Brook . . . the world's *most respected* motor—built by the world's *most experienced* manufacturer.





1. **Ceramic-coated stator laminations** provide excellent dielectric qualities and maximum resistance to heat.
2. **Stator slots insulated with mica-coated fabric**—highly resistant to water, oil, heat and electrical strain.
3. **Dynamically-balanced rotors** to eliminate vibration . . . a practically indestructible unit of pure copper or aluminum passing through rotor laminations.
4. **U. S. standard interchangeable ball bearings** in metric sizes. Mountings protected against dirt and moisture.
5. **Precision-ground shaft**—painstakingly ground to the highest, most exacting standards. Made of the finest, high tensile steel.
6. **All major types**—available from stock . . . open drip-proof, splash-proof, totally enclosed non-ventilated, totally enclosed externally fan-cooled . . . in a wide range of horsepower sizes.



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Get all the details about the complete Brook line . . . write today!

BROOK MOTOR CORPORATION

3555-57 W. Peterson Avenue, Chicago 45, Illinois

BROOK MOTOR CORPORATION

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PUROLATOR FILTERS

FULL-FLOW
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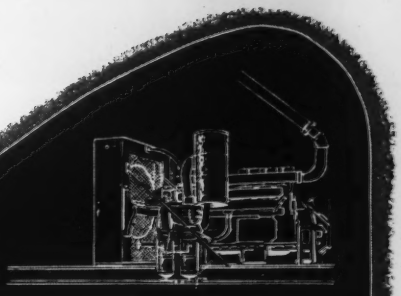
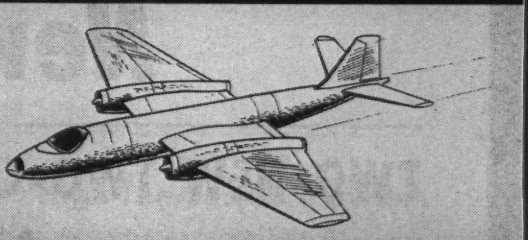
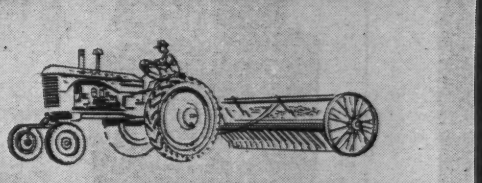
AIR







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NEXT TIME the question of filtration comes up, here's something worth remembering—

The majority of America's best known builders of internal combustion equipment choose Purolator* filters. In most instances, their choice is based on results of their own impartial tests. Purolator filters—inch for inch, and pound for pound—give finer, more dependable filtration at optimum flow rates.

Quickest way to get acquainted with the almost one thousand different types of Purolator filters is to send for the catalogs. Use the coupon!

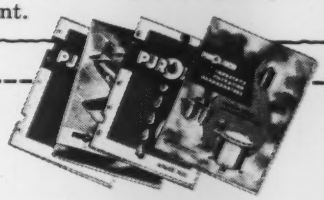
*Reg. U. S. Pat. Off.

PUROLATOR PRODUCTS, INC.
Rahway, New Jersey and Toronto, Ontario, Canada
Factory Branch Offices: Chicago, Detroit, Los Angeles

PUROLATOR
WORLD'S FINEST OIL FILTER

Do you have a problem in filtration?

Purolator maintains the world's largest specialized filter research and engineering laboratories. Your filter problems—small or large—are always welcome at Purolator's Engineering Department.



Purolator Products, Inc.
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Send the following
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Company_____

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Speeds to 10,000 RPM

WITHOUT VIBRATION

with uniform

Carpenter Stainless Tubing

Pictured at the left is a rather unusual shaft. Used in a flexible coupling installation it practically floats free in its bearings and is called upon to transmit heavy loads at speeds from 3,600 to 10,000 RPM.

It is made of Carpenter Stainless Welded Tubing for several reasons: Uniform wall thickness eliminates vibration. Perfect concentricity prevents shaft whip throughout entire speed range. High strength handles heavy torsional stresses. Light weight permits fast acceleration without undue power.

Obtaining all these things in a single length of tubing would not be difficult. But because hundreds of lengths are required without any variation the manufacturer specified Carpenter.

Write or phone your Carpenter representative for prompt service on tubing having an unusual combination of qualities plus engineering or design assistance.

The Carpenter Steel Company, Alloy Tube Division, Union, N. J.

Branch Offices: Atlanta Chicago Pittsburgh
Houston Newark San Francisco

Export Dept.: The Carpenter Steel Co., Port Washington, N.Y.
"CARSTEELCO"

more than corrosion resistance

Carpenter

STAINLESS TUBING & PIPE

← Analysis → ← Tolerance → ← Finish →

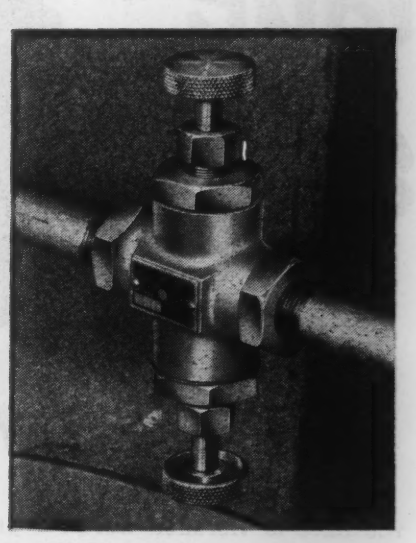
- guaranteed on every shipment

PROPER CONTROL OF AIR WITH *NORGREN* VALVES

gives you

- **better air equipment performance**
- **less equipment maintenance**
- **lower air costs**

Automatic Relief Valves protect equipment from damage resulting from excessive pressure build-up and provide controlled operation of fluid recirculating systems. ¼" to 1".

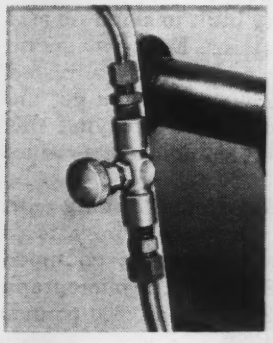


Adjustable Air Governors

Improve cylinder performance by accurately regulating work and return strokes. Two-way and single-way for lines carrying air, oil, water, steam, non-corrosive gases and liquids. ¼", ⅜", ½".

Blow Guns

For removing dust, chips, water, etc., from parts in production, work benches, machinery, dies, testing devices, office machines. Lever, button and flex types of air controls.



Needle Valves

Provide an adjustable orifice for controlling the rate of flow of air, liquids, and gases, or for use as shut-off valve. Pressures up to 250 psi. ⅛", ¼".

C. A. Norgren® CO.
3442 So. Elati, Englewood, Colo.

WRITE FOR NEW CATALOG SHEETS

PIONEER AND LEADER IN OIL-FOG LUBRICATION FOR 26 YEARS

Valves • Filters • Regulators • Lubricators • Hose Assemblies

Vibration testing made easier

Electronic component under test at Eclipse-Pioneer division of Bendix Aviation Corporation.

with the help of MB equipment like this

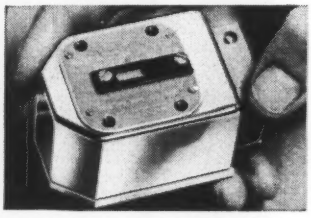
Do you have to vibration-test your product to meet military specifications? Want to apply shake-testing to improve product design or to control quality? If so, do what many leading companies have done—enlist the help of MB.

First, you get the right equipment. MB offers a *complete* line of vibration exciters from 10 pounds force all the way to the largest developed today—10,000 pounds! All are quality built to stand up and do the job right to specifications. Electromagnetic in operation, they're easily and quickly adjusted for force and frequency. And, second, you get the benefit of MB's wide experience in applying this relatively new and valuable technique for product improvement.

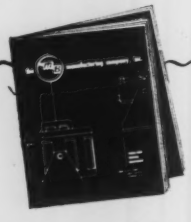
Among the well known companies working with MB products, Bendix Aviation Corporation's Eclipse-Pioneer division is outstandingly equipped with *several* MB Vibration Exciters. The photograph shows one—MB Model C-25, rated at 2500 pounds of force—vibrating an electronic component to insure dependability under severest conditions. Such testing can uncover, in minutes, trouble that might take months to develop.

VIBRATION PICKUP ANOTHER USEFUL TESTING TOOL

When you want to detect vibration and determine its nature, you'll want an MB Vibration Pickup. While the pickup detects even slightest vibratory motion, it was built for grueling service as well. Model 122 withstands temperatures up to 500°F.



Control panels for all MB shakers, as in the photo above, can be furnished with MB Vibration Meter for use with pickup. This meter gives direct velocity, acceleration and amplitudes of the picked-up vibration.

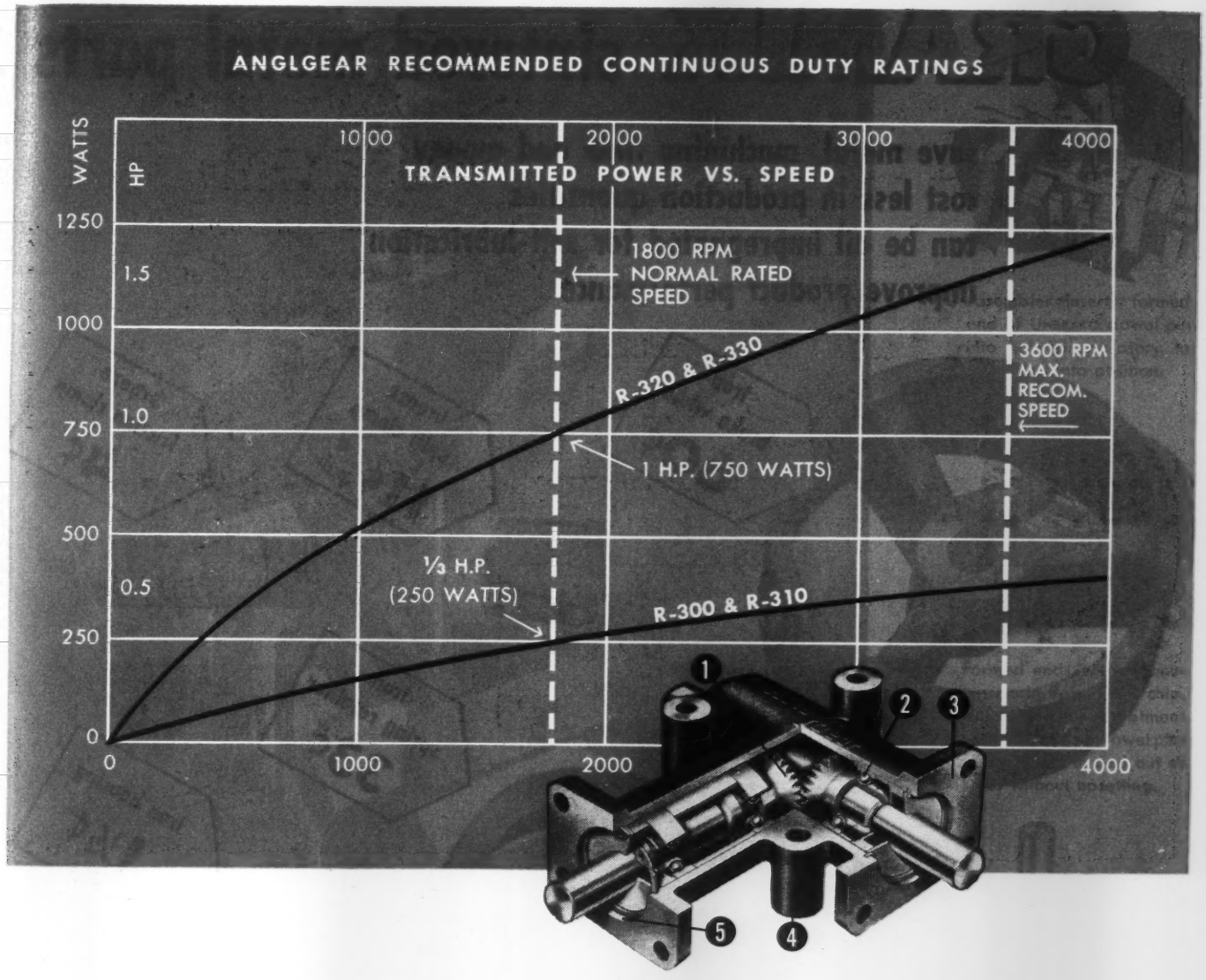


Bulletins you'll welcome

How to calibrate vibration pickups to 2000 cps—Bulletin C-11-3 reviews the subject comprehensively. Bulletin 1-VE-3 tells all about MB Vibration Exciters. Write for them.

THE MB MANUFACTURING COMPANY, INC.
1060 State Street, New Haven 11, Conn.

'HEADQUARTERS FOR PRODUCTS TO INDUCE VIBRATION...TO MEASURE IT...TO ISOLATE IT



WHY WE PUT NEW TEETH IN ANGLGEAR

When a right-angle gear runs quietly, you know that bearing between teeth is even, and that load is balanced perfectly. You know, too, that the teeth will never chip or shear. The new Coniflex design provides just this kind of smooth, noiseless operation. That's why we added it to ANGLgear. Our electronic "ear," which checks each finished unit, was first to record the improvement. Since then, engineers have told us that in addition to having the *original* right-angle gear, we also have the *quietest!*

1. Coniflex gears
2. Antifriction bearings
3. Flanged end mountings
4. 3-bolt side mounting
5. Internal pilot on mounting ends
6. 1-1 ratio

Model	Type	H.P.	R.P.M.	Static Torque Capacity (in lbs.)	Shaft Dia. Inches	Wt.
R-300	2 WAY	⅓	1800	250	⅜	½ lb.
R-310	3 WAY	⅓	1800	250	⅜	½ lb.
R-320	2 WAY	1	1800	1000	⅝	2½ lb.
R-330	3 WAY	1	1800	1000	⅝	2⅜ lb.

ENGINEERED EQUIPMENT FOR AIRCRAFT AND INDUSTRY

AIRBORNE

ACCESSORIES CORPORATION

HILLSIDE 5, NEW JERSEY

SEE OUR LITERATURE

in Product Design Section of Sweet's Catalog. ANGLgears are sold only through your local distributor. Contact him, or write us for further information.

GRAMIX® sintered metal parts

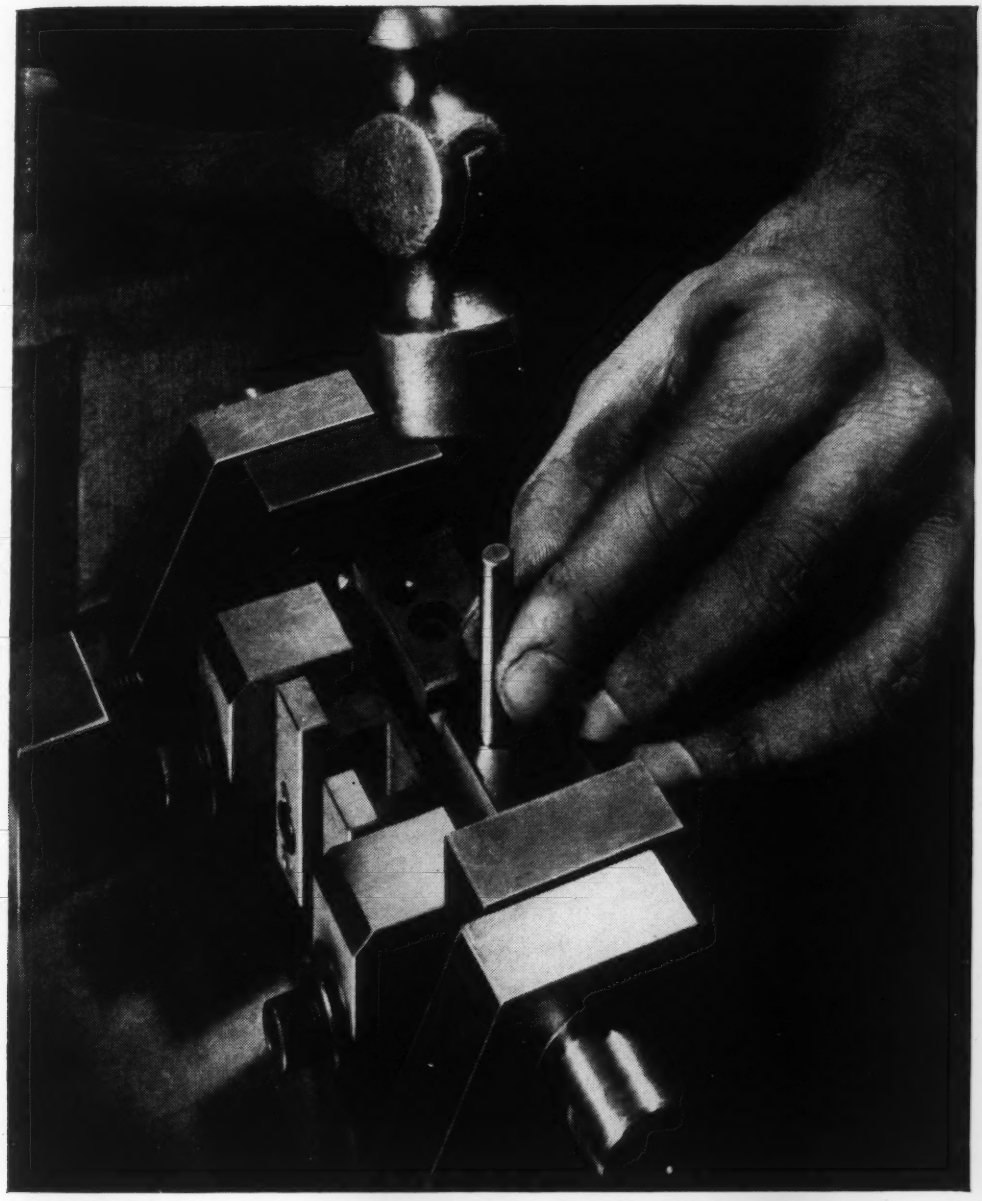
save metal, machining time and money
cost less in production quantities
can be oil impregnated for self-lubrication
improve product performance

103

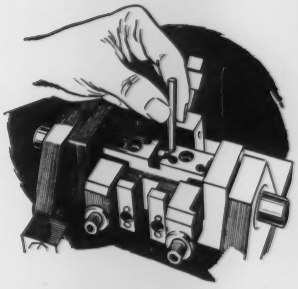
OUR 100th YEAR

THE UNITED STATES GRAPHITE COMPANY

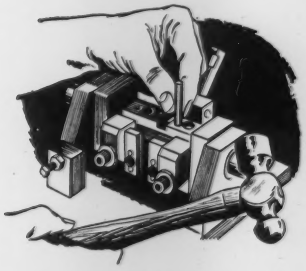
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN



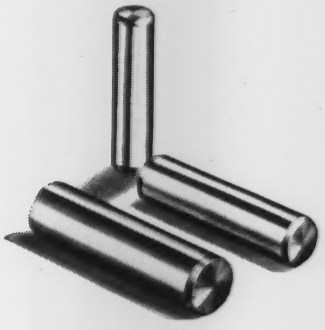
UNBRAKO Precision-Ground Dowel Pins are widely used for aligning parts, as in dies, jigs and fixtures. This radius grinding fixture, for putting a flat on electronic shafting, is a good example of such an application.



Assembler inserts formed end of UNBRAKO dowel pin into hole preparatory to tapping it into position.



Formed ends, with continuous grain flow, won't chip. Uniform heat treatment permits UNBRAKO dowel pins to be driven in and out of holes without upsetting.



UNBRAKO dowel pins—made of heat treated alloy steel—have a surface hardness of 60-62 Rockwell "C" Scale; a surface finish of 6 microinch maximum; a core hardness of 50-54 Rockwell "C" Scale; an average single shear strength of 150,000 psi; and a diameter tolerance of ±0.0001". They are available in two standard sizes in diameters from ⅛" to 1".

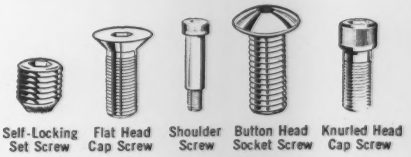
Keep your inventory at a minimum

Use UNBRAKO Standards—stocked by your distributor

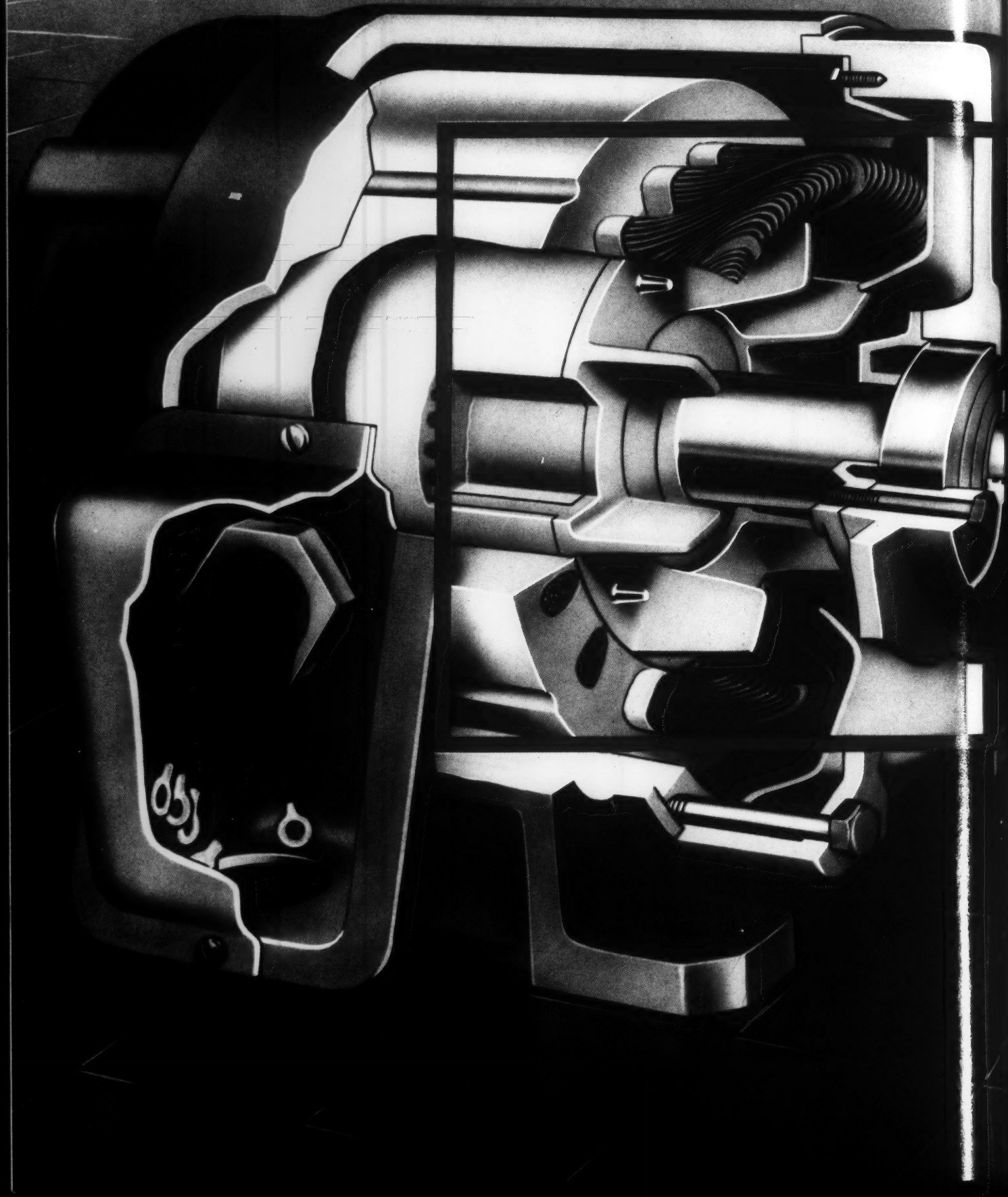
Because your UNBRAKO distributor stocks a full line of standard UNBRAKO socket screw products, your inventory is lowered. This ready supply not only cuts your investment, but gives you faster delivery and reduces your buying costs. For a complete listing of standard UNBRAKO products, see your distributor or write STANDARD PRESSED STEEL CO., Jenkintown 18, Penna.

UNBRAKO® SOCKET SCREW DIVISION

SPS JENKINTOWN PENNSYLVANIA



Get Greater
with New Features



Motor Economy
. . . Proved Principles

Here's the inside story of a great new motor. It combines the best of the new developments in methods and materials with the best of the tried and proved principles that have made such an outstanding record for Allis-Chalmers motors.

Smaller in size than previous designs, it offers greater protection against damage from falling liquids and solids. The bearing design gives greater bearing protection, ease of maintenance and long life. Insulation gives you famous Allis-Chalmers rugged dependability.

Consult your nearby Allis-Chalmers Authorized Distributor or District Office on your motor needs. Or write for Bulletin 51B6210.

STATOR DOUBLE INSULATED—Stator laminations are welded across back for rigidity. Heavy varnished cambric insulation is inserted between phase windings. Wound stator is dipped several times in special insulating varnish of proved effectiveness and stamina, and baked after each dip. The Allis-Chalmers stator is both physically and electrically strong . . . thoroughly protected against moisture, heat and corrosion.

RIGID CAST-IRON FRAME—Heavy, distortion-free cast-iron frame holds bearings in rigid alignment . . . gives all-around protection against physical damage . . . resists rusting.

Air intakes are well protected by being located on the underside of the end housing. There is plenty of room for free air circulation on the back of the stator core for efficient, even cooling. Air is discharged horizontally and to the sides.

Multiple bearing protection keeps grease in . . . keeps dirt out . . . permits relubrication in service

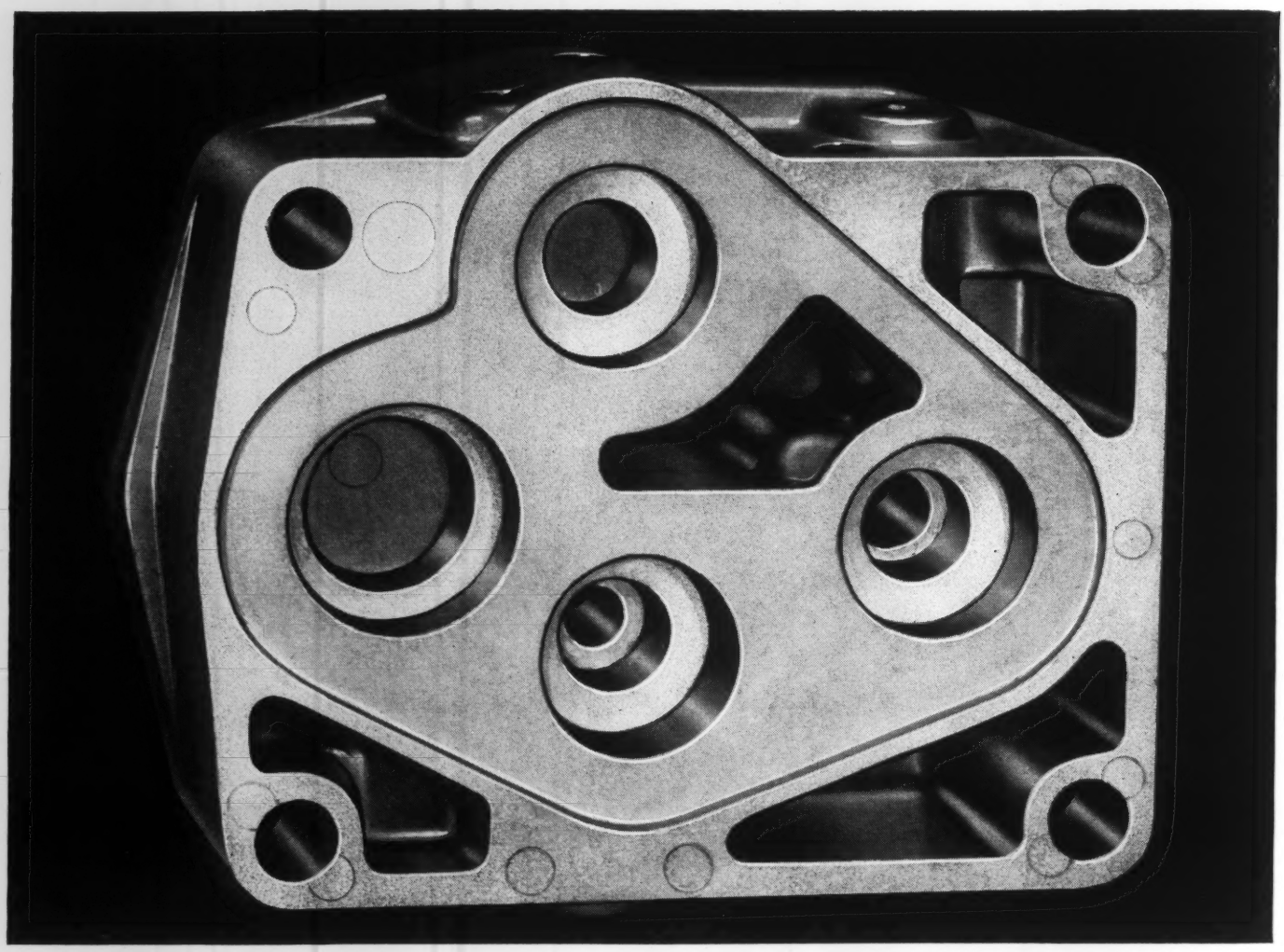
Extreme care has been taken to provide longest possible bearing life and lowest possible maintenance costs. The bearing itself is of double-shielded type, which allows controlled migration of grease in and out of the bearing to suit operating conditions. Yet bearing is protected against greatest cause of bearing trouble — overgreasing.

Close running clearances and double labyrinth seals between the shaft and outer bearing housings keep grease in the bearing and exclude dirt. Grease is kept out of the interior of the motor by a bearing cap with a long running clearance along the shaft. The cap is held tightly in place by hex head cap screws. Large grease chambers hold an ample supply of lubricant.

A-4362

ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN



GRADE A DESIGNING with MADISON-KIPP zinc and aluminum die castings

Only a highly qualified engineer would be assigned the job of designing a selector valve like the one here illustrated. He can often do his best work by also utilizing the seasoned skill of Madison-Kipp craftsmen.

Please note the significant coring so vital to valving. There is Grade A Designing involved by both the principal and die casting contractor—Madison-Kipp.

We will welcome your inquiries.

kipp

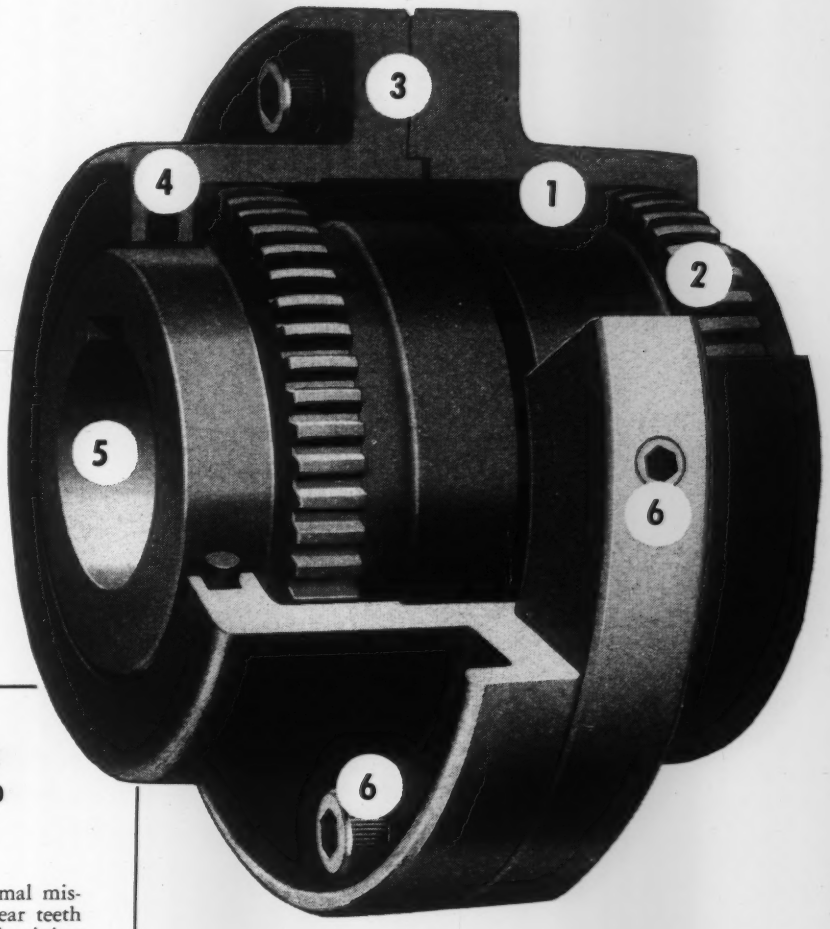
MADISON-KIPP CORPORATION
210 WAUBESA STREET • MADISON 10, WIS., U.S.A.

- Skilled in Die Casting Mechanics
- Experienced in Lubrication Engineering
- Originators of Really High Speed Air Tools

Now you can choose a smaller, lighter, lower-cost coupling

New LINK-BELT Geared Flexible Couplings have greater bore capacity than other leading makes

Approx. outside dia. (in.)	Max. bore of Link-Belt coupling (in.)	Largest bore available in most leading makes (in.)
4 9/16	1 1/2	1 3/8
6	2 1/8	1 1/2
7	2 3/4	2
8 3/8	3 1/2	2 1/2
9 1/2	4	3



Check these 6 ways Link-Belt achieves compactness with no sacrifice of load capacity

1. Minimum backlash with capacity for normal misalignment. Extra wide face of internal gear teeth provides for reasonable end float while maintaining full tooth contact.
2. Crowned hub teeth will not bind in root of housing teeth.
3. Rigidity of the two-piece housing is attained with special hardened steel cap screws and lock washers firmly joining the rabbet fitted mating surfaces.
4. Positive lubricant retention with O-ring seals.
5. Long steel hubs assure good bearing on shaft.
6. Easier assembly and disassembly — An Allen Wrench is the only tool required.

Get all the facts on Link-Belt Geared Flexible Couplings. Ask your Link-Belt engineer or distributor for Folder 2375 or tear out the handy coupon at the right and mail it today.

LINK-BELT

GEARED FLEXIBLE COUPLINGS

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,483

LINK-BELT COMPANY
220 S. Belmont Ave., Indianapolis 6, Ind.

Please send me immediately a copy of Folder 2375, covering Geared Flexible Couplings.

Name .....

Firm .....

Position .....

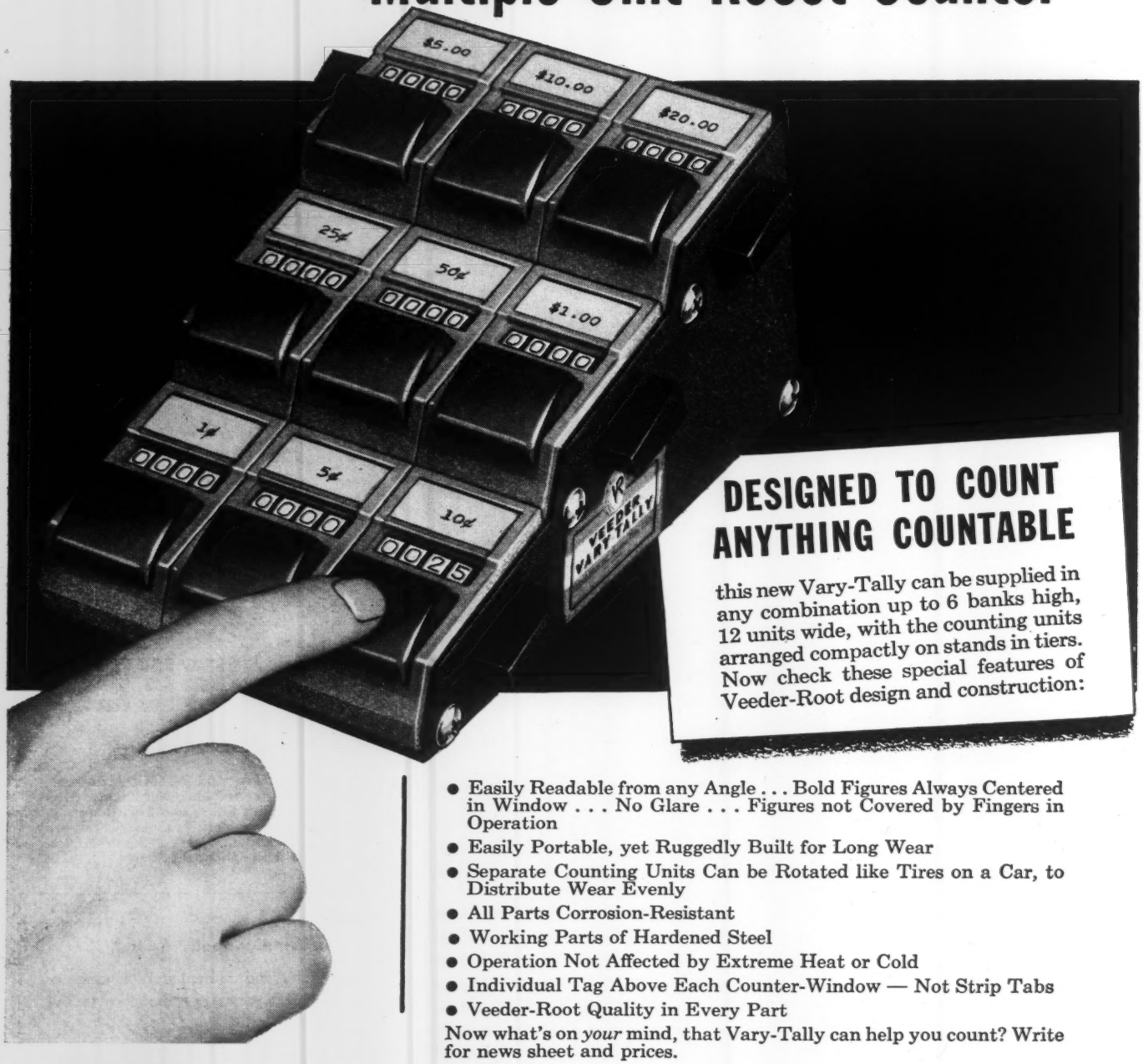
Address .....

City..... Zone.... State.....

New!

VARY-TALLY

Multiple-Unit Reset Counter



DESIGNED TO COUNT ANYTHING COUNTABLE

this new Vary-Tally can be supplied in any combination up to 6 banks high, 12 units wide, with the counting units arranged compactly on stands in tiers. Now check these special features of Veeder-Root design and construction:

- Easily Readable from any Angle . . . Bold Figures Always Centered in Window . . . No Glare . . . Figures not Covered by Fingers in Operation
- Easily Portable, yet Ruggedly Built for Long Wear
- Separate Counting Units Can be Rotated like Tires on a Car, to Distribute Wear Evenly
- All Parts Corrosion-Resistant
- Working Parts of Hardened Steel
- Operation Not Affected by Extreme Heat or Cold
- Individual Tag Above Each Counter-Window — Not Strip Tabs
- Veeder-Root Quality in Every Part

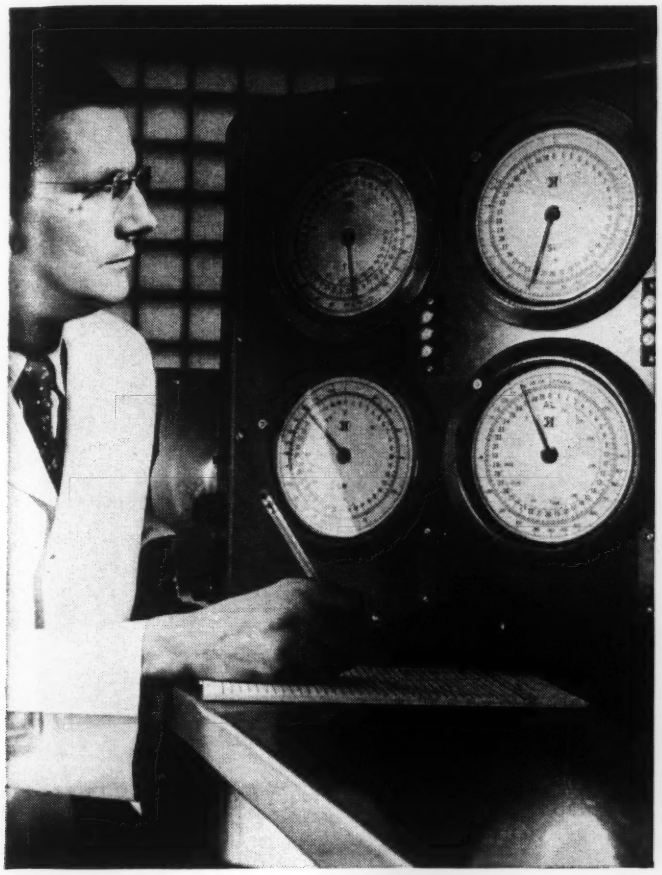
Now what's on *your* mind, that Vary-Tally can help you count? Write for news sheet and prices.

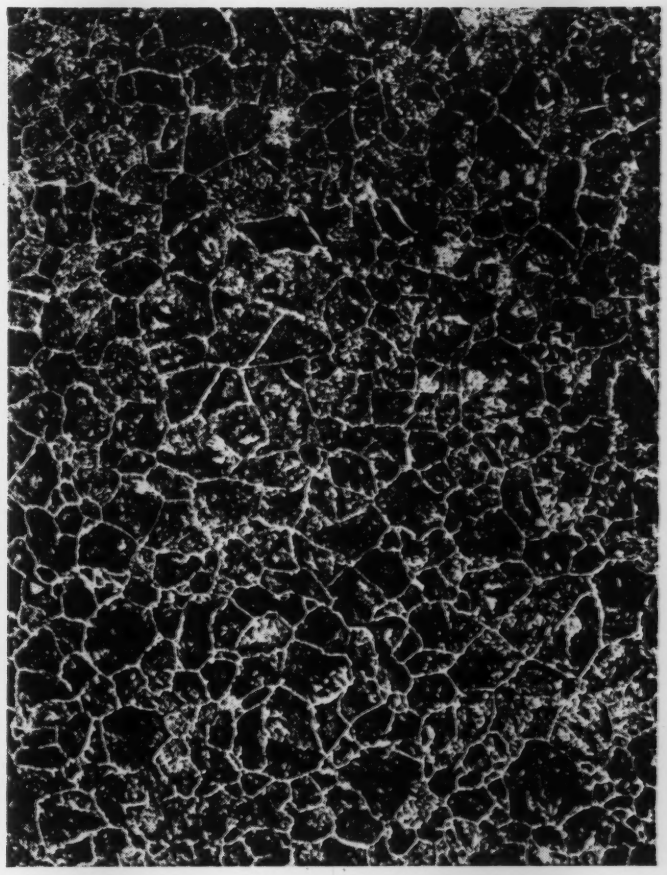
"The Name that Counts"

VEEDER-ROOT INC.

HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C. • Montreal 2, Canada • Dundee, Scotland • Offices and Agents in Principal Cities





Meet two of the reasons why TIMKEN® forging steels give you uniform, high-quality forgings

THE man on the left helps assure you of uniform composition in every Timken® steel forging bar. With this spectrometer, he can tell the exact composition of a melt in just 40 seconds. Results are flashed back to the furnace so the melter can maintain constant control of the heat analysis up to the instant of pouring.

The photomicrograph at right shows the uniform grain size of the Timken forging steels. Uniform grain size after heat treatment is assured by spectrometric or microscopic examination of every heat. The result—you can be sure that forgings made from Timken forging steels have uniformly high ductility and resistance to impact.

But that's only part of the story. You can hold rejects to a minimum because we condition the steel to fit your particular forging requirements. And you save steel because the good dimensional tolerances of Timken forging steels produce uniform weight multiples with a minimum of steel lost in flashings. You even have fewer furnace adjustments because Timken forging steels respond uniformly to heat treatment.

For help in improving the quality of your forgings and cutting production costs, write: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

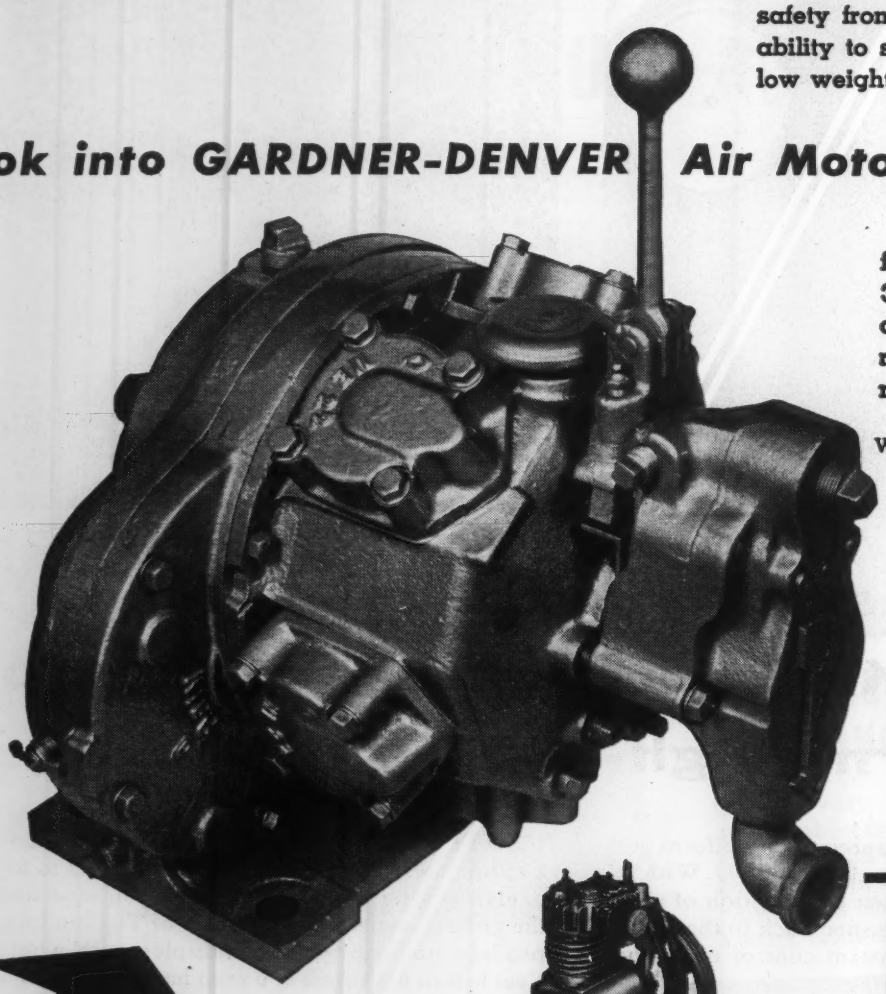
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

when power specs demand:

high torque at low speed
smooth power at every speed
flexibility of control
safety from electric sparks
ability to stall without damage
low weight per horsepower

look into GARDNER-DENVER Air Motors

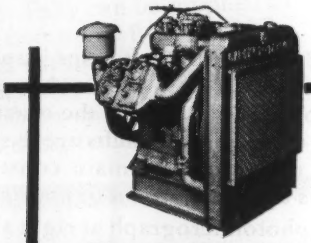


five sizes
3 to 15 h.p.
direct or geared
reversible or
non-reversible

Write today for Bulletin AM-1.

and look to Gardner-Denver for quality air compressors

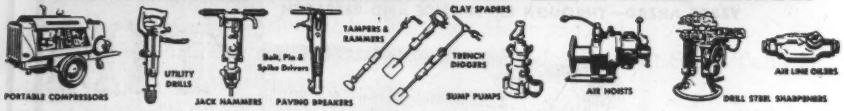
Air-Cooled Model ADD



Water-Cooled Model WBQ

SINCE 1859

GARDNER-DENVER



THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS
FOR CONSTRUCTION, MINING, PETROLEUM AND GENERAL INDUSTRY

Gardner-Denver Company, Quincy, Illinois
In Canada: Gardner-Denver Company (Canada) Ltd.,
14 Curity Avenue, Toronto '91 Ontario

For Designs that Demand ACCURATE Adjustable Voltage

POWERSTAT
variable transformers
Hit the Voltage "On the Nose"

If the equipment you are designing calls for *accurate* adjustable voltage, take advantage of the "precision-accuracy" of a POWERSTAT variable transformer. Plus — its excellent regulation . . . high efficiency . . . cool operation . . . and long life.

And the cost? You can buy a POWERSTAT for as little as $8.50!

POWERSTATS are designed to fit your designs. They make life easy for designers. Dimension-wise and mounting-wise, a POWERSTAT is easiest to install . . . and maintenance is negligible. Write for full details.

Manually-operated and motor-driven POWERSTATS are offered in 120, 240 and 480 volt ratings — from 150VA to 100 KVA.

Be sure to see Superior Electric's Mobile Display when it visits your area.

THE SUPERIOR ELECTRIC COMPANY

1206 CLARKE AVENUE, BRISTOL, CONN.

Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

THE SUPERIOR ELECTRIC CO.
1206 Clarke Ave., Bristol, Conn.

Please send complete literature on Powerstat variable transformers.

Name .....

Position .....

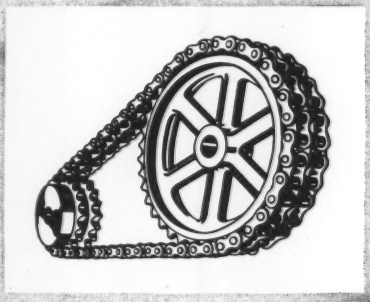
Company Name .....

Company Address .....

City ..... Zone ..... State .....

CULLMAN ROLLER CHAINS

for POWER transmission efficiency



Dependable

Precise • Efficient

In the design stages consider these basic power transmission factors . . . cost, efficiency, flexibility, load distribution, space, strength, fixed speed ratios . . .

And then remember that each and every link of Cullman Roller Chain is manufactured to exacting standards that answer these problems . . . *and many more.*

By writing today, you can obtain information that will help you solve your power transmission problems. Cullman offers the services of its qualified engineers and field men to help you in every way.

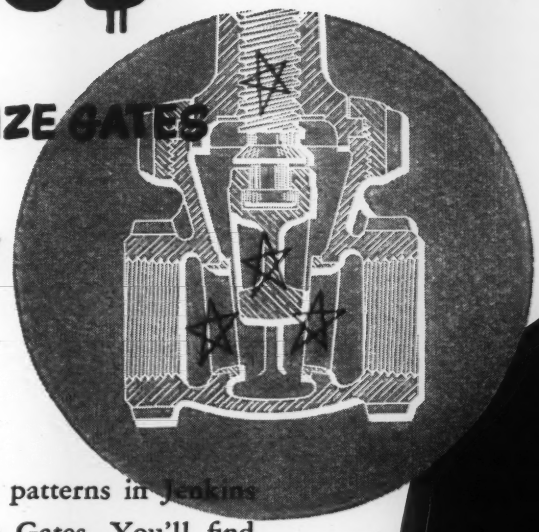
CULLMAN power transmission

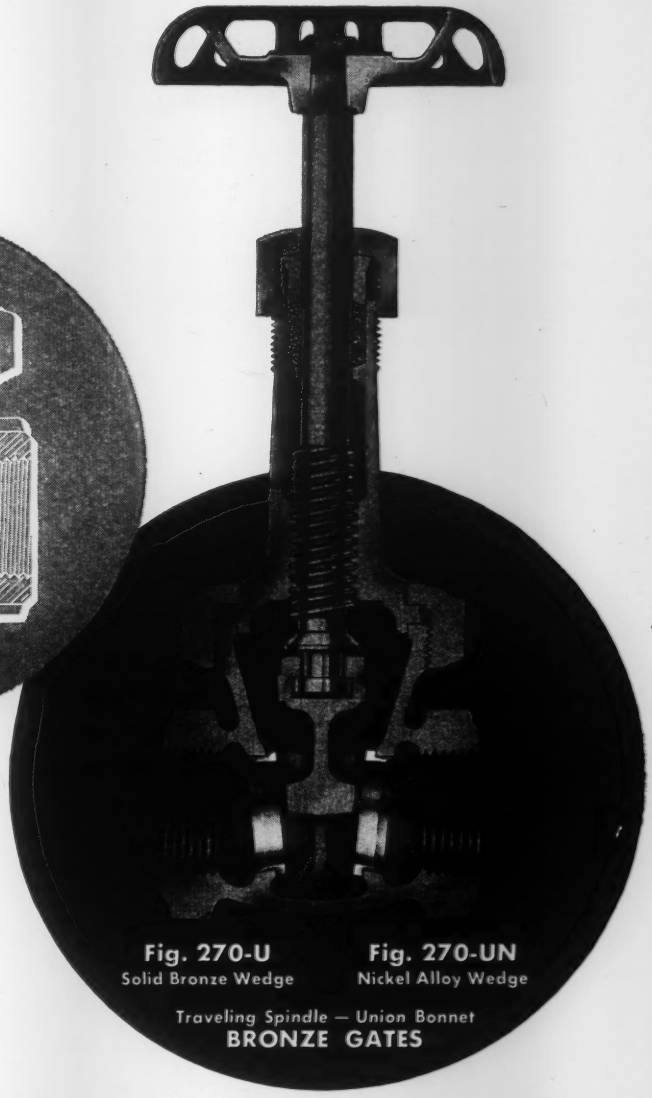
ROLLER CHAINS and SPROCKETS

CULLMAN WHEEL COMPANY • 1336 ALTGELD STREET • CHICAGO 14, ILLINOIS

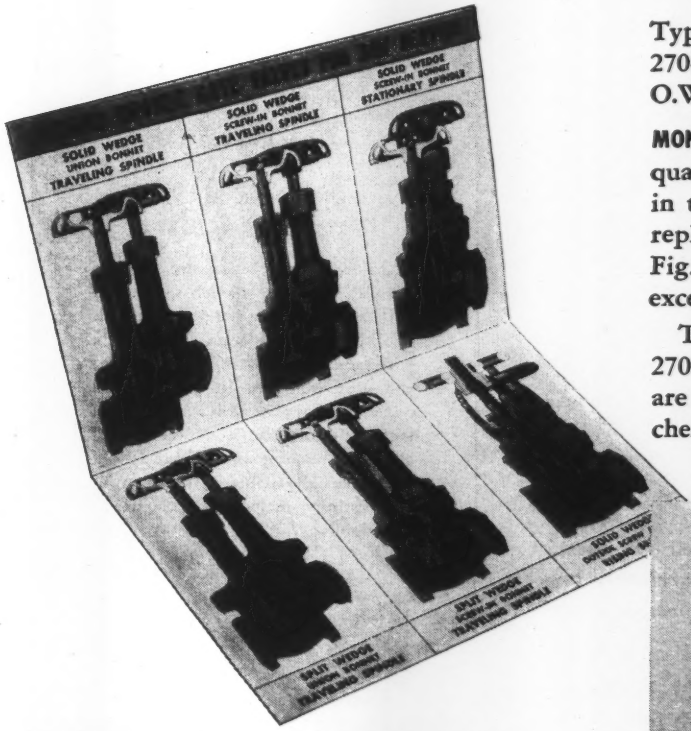
REPRESENTATIVES AND DISTRIBUTORS IN ALL PRINCIPAL CITIES

Built-in $AVING$ make JENKINS BRONZE GATES your BEST BUY





Look over any of the 35 patterns in Jenkins complete line of Bronze Gates. You'll find *savings* built into every valve. Jenkins valve specialists designed each one for easy maintenance and extra long wear. Try them on your toughest services and see why they take top-rating in any test for endurance and economy. Jenkins Bros., 100 Park Ave., New York 17.



Jenkins Bronze Gate folder shows the many types available — lists convincing reasons why they are your best buy for any service. Ask for Form 181-A.

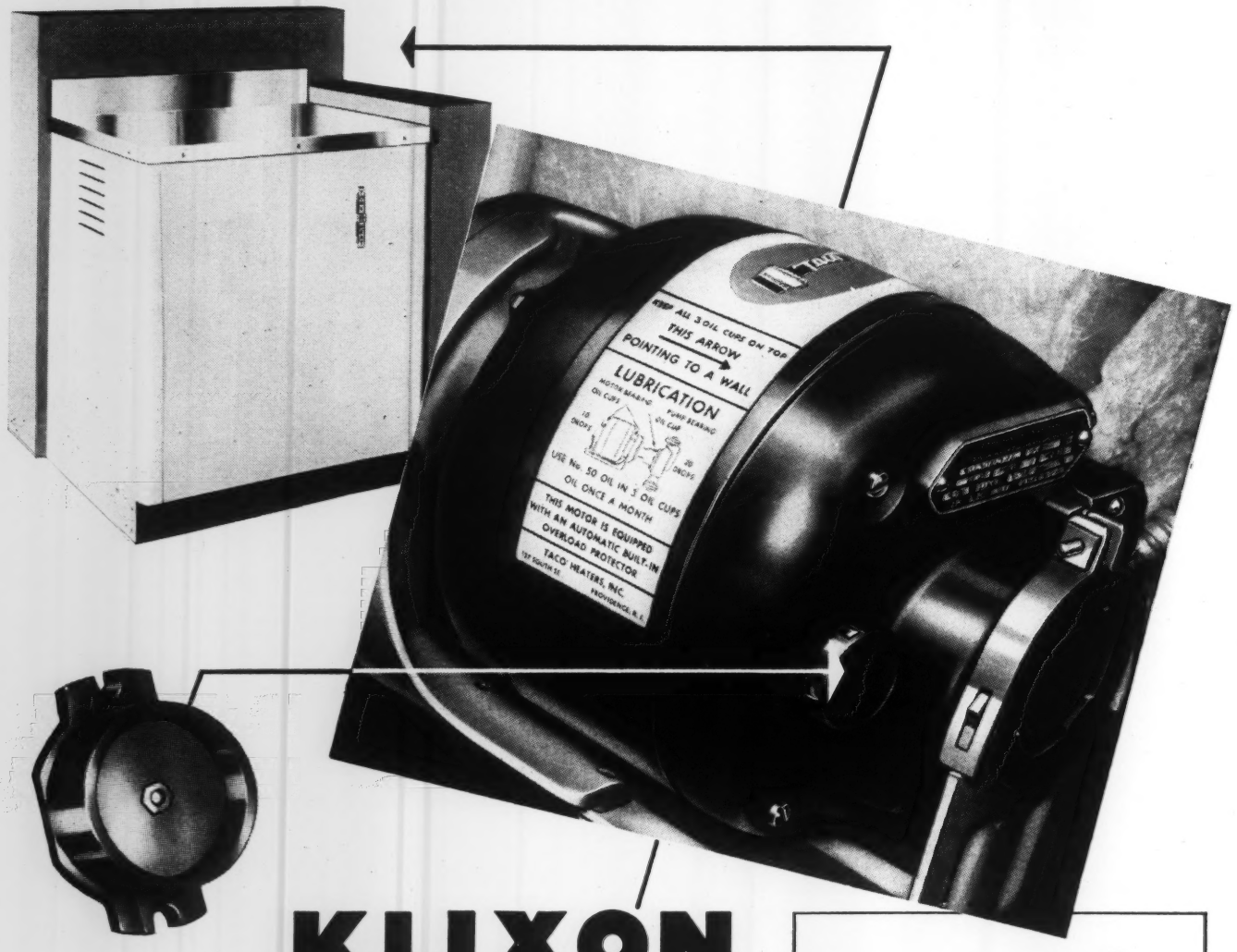
Typical of Jenkins design for built-in savings are the Fig. 270-U and Fig. 270-UN Gates for 200 lb. Steam, 400 lb. O.W.G. services.

MONEL AND BRONZE SEATING COMBINATION In Fig. 270-U a high quality bronze wedge seats against MONEL rings expanded in the body. The wedge takes the wear — it can easily be replaced when necessary by slipping a new one on the stem. Fig. 270-UN, with a nickel alloy wedge, is recommended for exceptionally severe conditions of rapid wear and corrosion.

These and other features of rugged construction make Figs. 270-U and 270-UN first choice for economy where conditions are most destructive to valves, as in oil refineries, dye houses, chemical, food, and rubber plants.

JENKINS
LOOK FOR THE DIAMOND MARK
VALVES
SINCE 1864
Jenkins Bros.

SOLD THROUGH LEADING INDUSTRIAL DISTRIBUTORS



KLIXON PROTECTORS

Help keep the "heat on" in York-Shipley Boiler Units

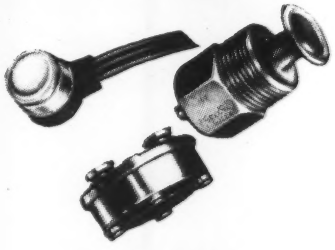
Modern in design, compact for space saving, the York-Shipley oil-fired, table-top boiler units provide plenty BTU's for outstanding home and hot water heating.

York-Shipley engineers specify and use motors with built-in Klixon Protectors to insure dependable, long-lived motor operation.

Here's what Mr. H. Leroy Mohn, project engineer, has to say about Klixon Protection:

"We prefer Klixon built-in motor protection in our oil burner and circulating pump motors because we find they reliably protect motors against unusual load conditions. Our experience with these protectors has been excellent."

You, too, can keep motors in your equipment operating, reduce service calls and repairs by specifying and using Klixon protected motors. The additional cost is low, pays for itself over and over by reducing motor burnouts.



KLIXON THERMO-SNAP TEMPERATURE CONTROLS

Actuated by the snap-acting Spencer Disc, these controls open the circuit with a quick, clean break; close with a solid make. Their accurate operation withstands shock, vibration, motion and altitude. Used in military and commercial applications ranging from tanks, aircraft, sterilizers, radio and electronic equipment to household appliances. Available in many types and ratings including hermetically sealed units.

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Division of Metals & Controls Corp.

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connect with cannon!

Are you looking for complete electrical circuit dependability in a very, very small space?

If so, you should use Cannon carefully engineered miniature and sub-miniature multi-contact connectors. In ½ or ⅓ the usual space, they give you up to 50 contacts, the same number as a standard connector, and still retain **all** the factors of utility, reliability, and mechanical strength found in Cannon's standard size connectors. They are very rugged, easy mating, unusually versatile, neat and compact.

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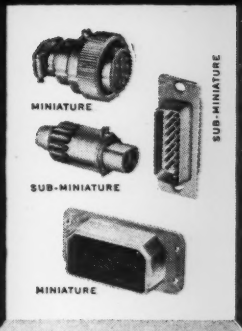

first in connectors

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Write for Cannon Miniature and Sub-Miniature Bulletins

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CANNON ELECTRIC COMPANY, 3209 Humboldt Street, Los Angeles 31, California.

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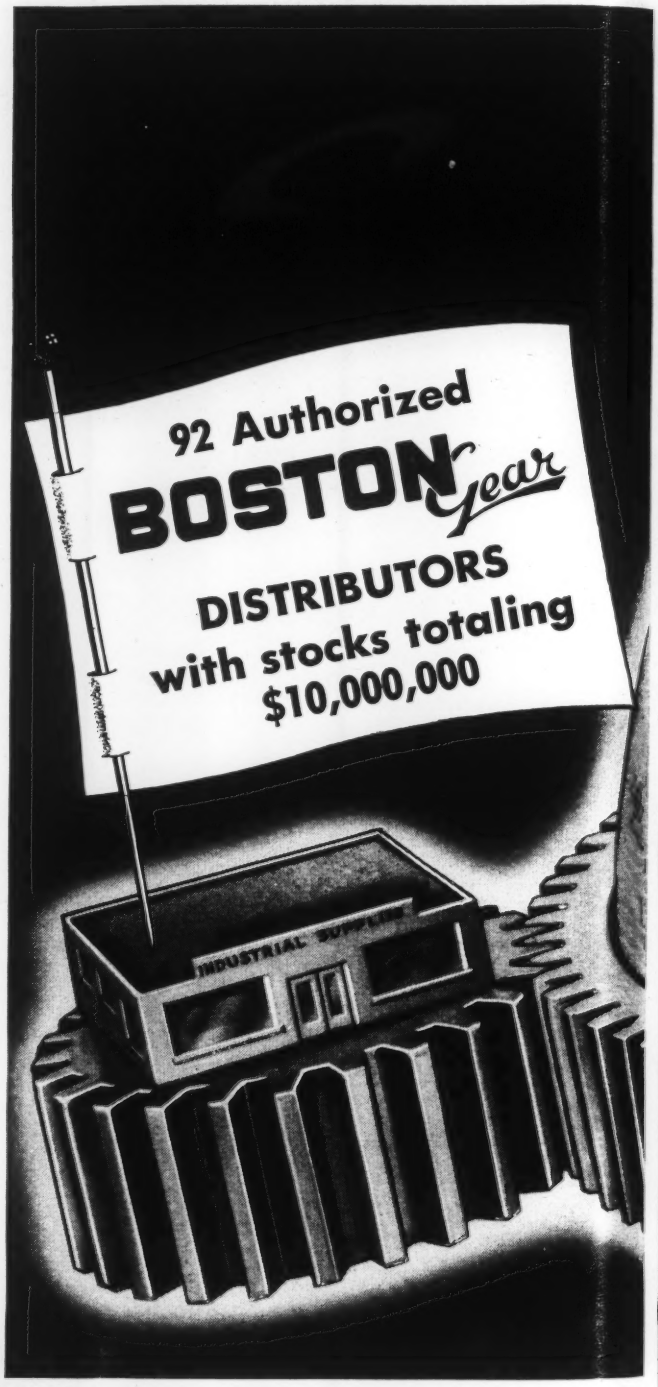

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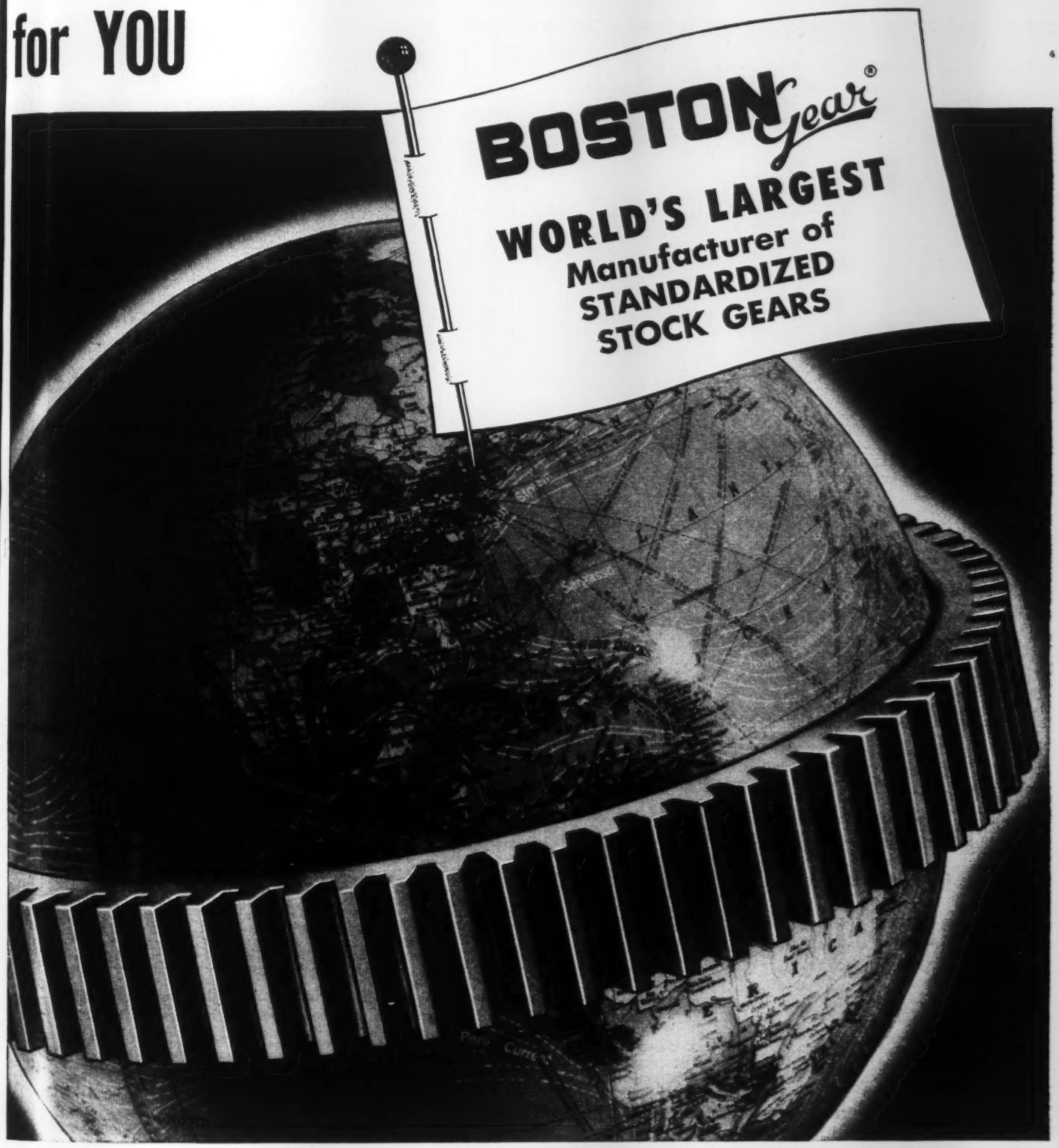

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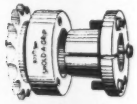

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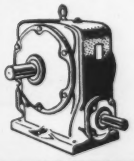
REDUCTORS



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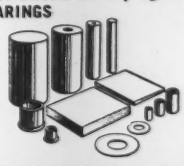

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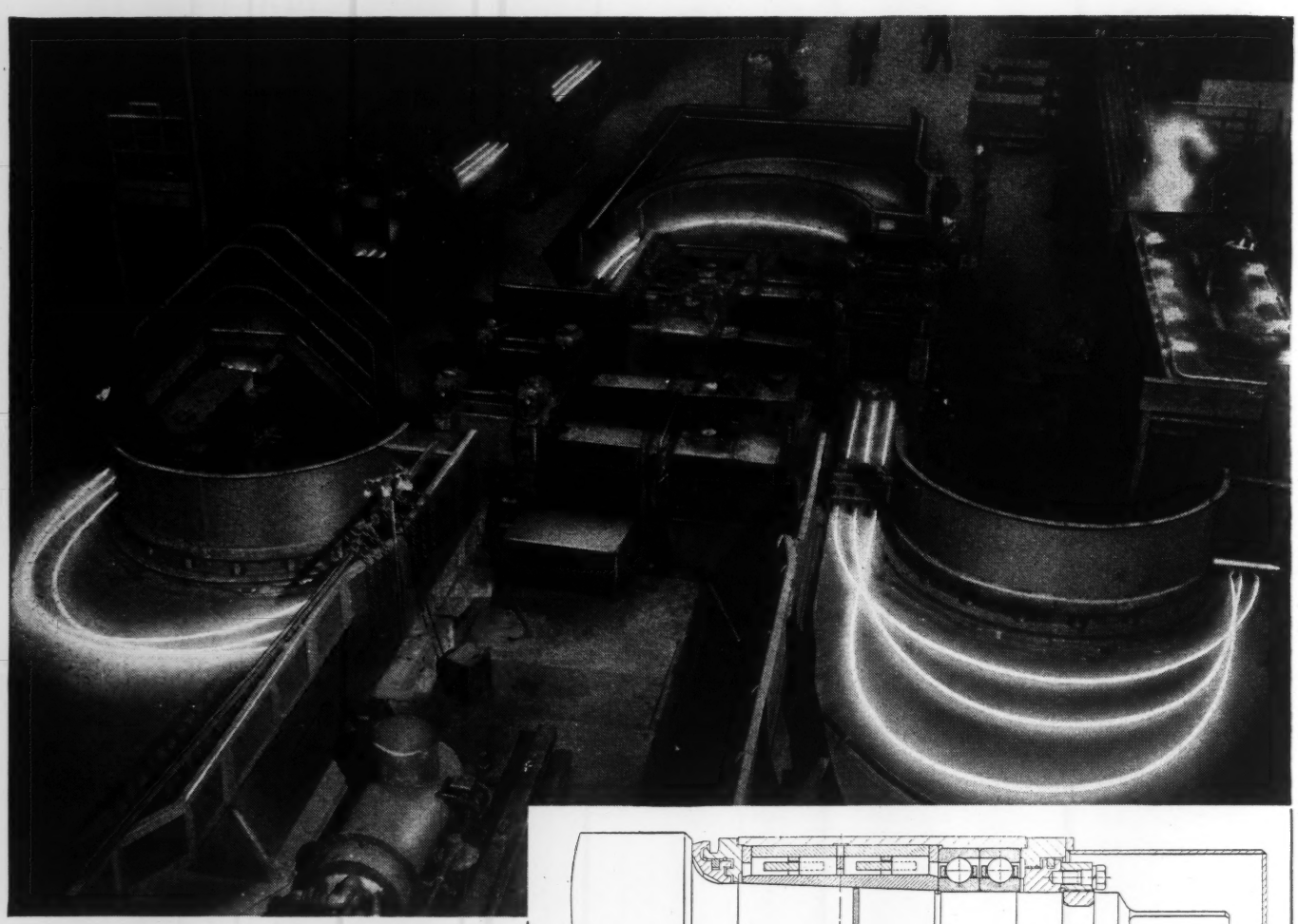
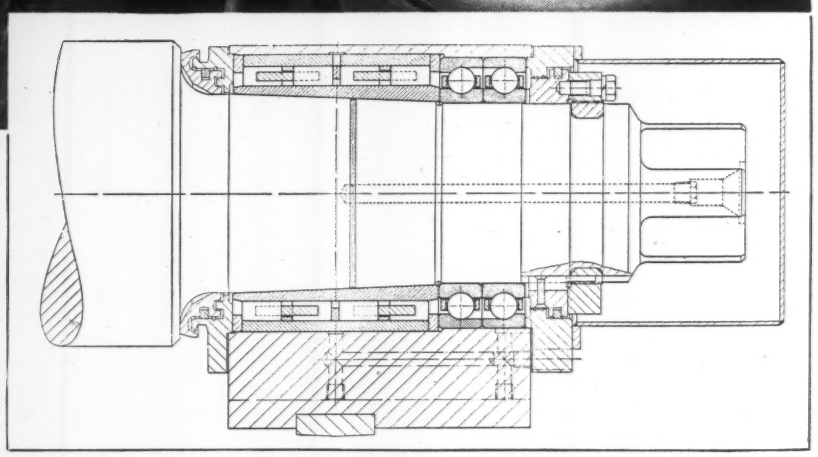


top quality rod
at better than
50 miles per hour



SKF Roll Neck as installed in United's Rendleman Mill at Jones & Laughlin. Dotted lines show oil passages for quick, easy bearing removal by the SKF-pioneered Hydraulic Removal System.

SKF multi-row cylindrical bearings installed on the roll necks of the Jones & Laughlin Rendleman rod mill by United Engineering and Foundry Company, are doing an outstanding job at mill speeds of 4700 feet per minute.

The SKF multi-row cylindrical bearing was specifically designed for roll neck applications. This four row grease lubricated bearing incorporates all those necessary qualities for the highest standards of roll neck bearing performance long desired by mill builders.

This is another example of SKF leadership in the rolling mill field. Consult SKF and have *them* help *you* "put the right bearing in the right place."

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for original or accessory equipment on Hydraulic Units, Engines, Machine Tools, Vacuum Pumps, etc.

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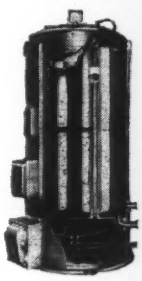

Available in many types and sizes to provide needed range in capacity. Use bulk refills or cartridges. Remove all types of contamination.

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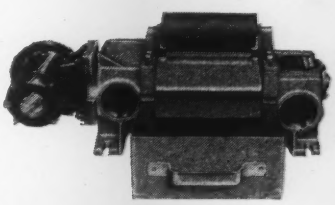

Magnetic Type—New magnetic separator is small, compact and powerful. Ideal for installation on individual machine tools of all types.

Mechanical Type—"T" Type Clarifier removes solid contaminants from oils and coolants. Designed for installation directly in the oil system to use pressure of machine tool sump.

AUTOMATIC CONVEYORS

Collect, transport and discharge all types of solid or fibrous materials which settle to bottom of tanks or hoppers. System eliminates manual handling methods, requires little maintenance.

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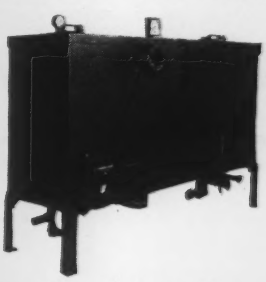

For removal of water from turbine, hydraulic and vacuum pump oils. Easy-to-install DRI-PURE filters out contaminants while removing water. Eliminates changing or discarding of oil.

A filter problem? Conveyor problem? Write today to Honan-Crane for sound, intelligent help backed by more than 30 years' experience in the industrial filter field. Honan-Crane manufactures a full line of equipment that can be adapted to your specific problems. Sales engineers in principal cities.

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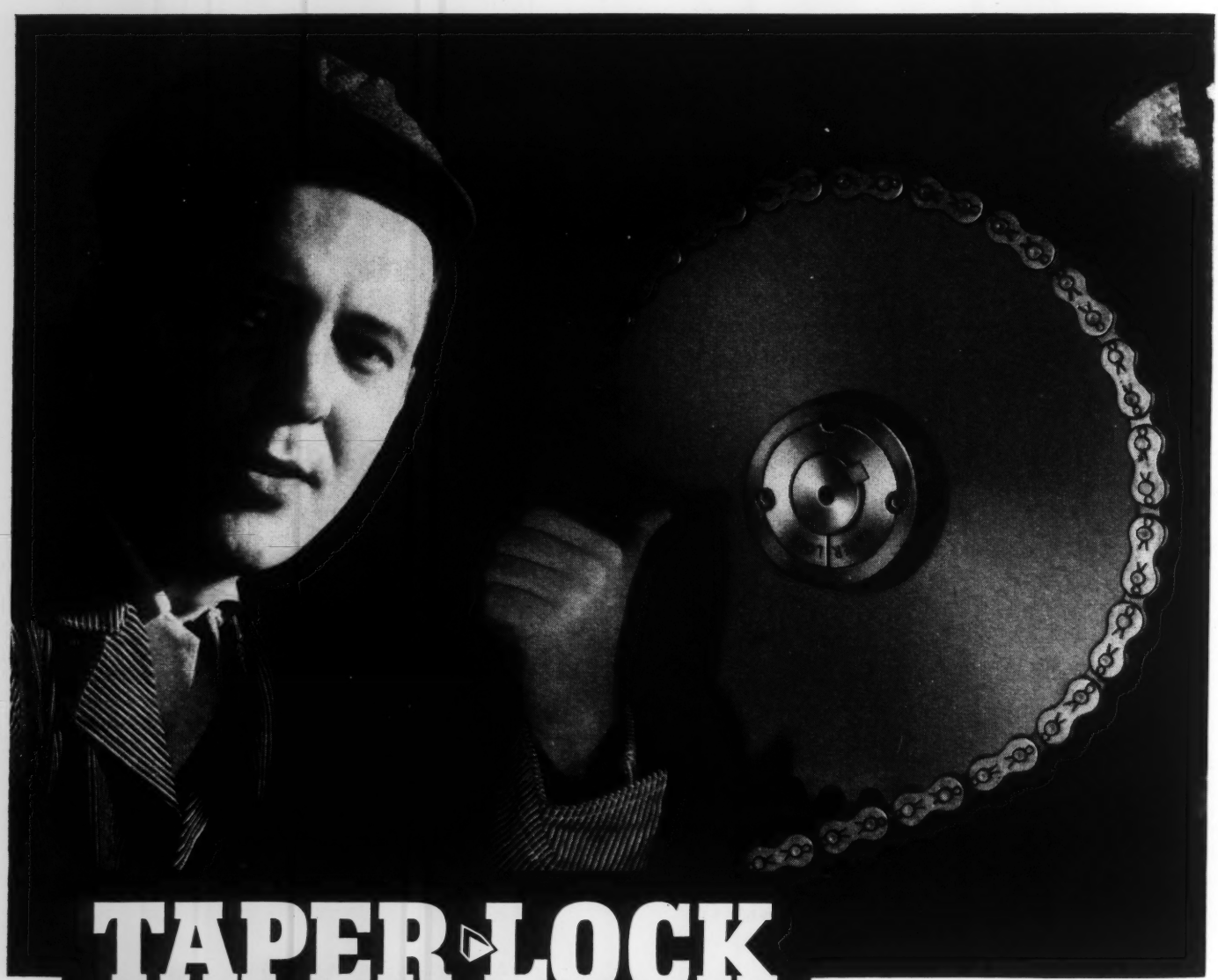

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A PATENTED PRODUCT OF DODGE

Holds so tight it will twist a cold-rolled shaft!

Yes, the Taper-Lock bushing really grips the shaft—holds with the firmness of a shrunk-on fit. It seats evenly along the entire length of the hub. There's no collar, no protruding part, no flange to prevent uniform compression. Having full contact with both hub and shaft, the Taper-Lock bushing holds so tight it would twist a cold rolled shaft before it let go. *Until you want to demount it!* Then a few turns of a hex wrench will release it quickly and completely, without shock to bearings or machinery. For the full story call your Distributor—or write to

DODGE MANUFACTURING CORPORATION, 3300 Union St., Mishawaka, Ind.

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Standardize, economize with Taper-Lock, the bushing that is interchangeable in Dodge sprockets, sheaves, couplings and conveyor pulleys. *More than 2,000,000 in use!*

CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new, cost-saving methods. Look for his name under "Power Transmission Machinery" in your classified telephone directory, or write us.

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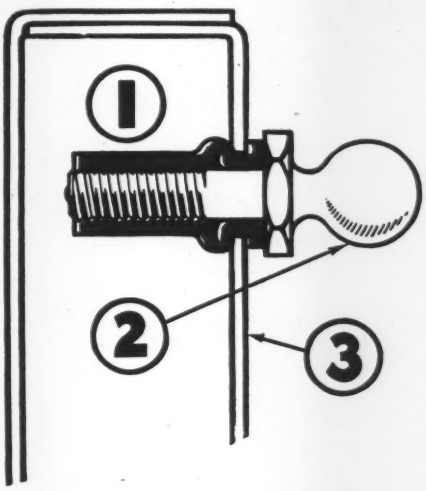
of Mishawaka, Ind.

One B. F. Goodrich RIVNUT solves 3 fastening problems!

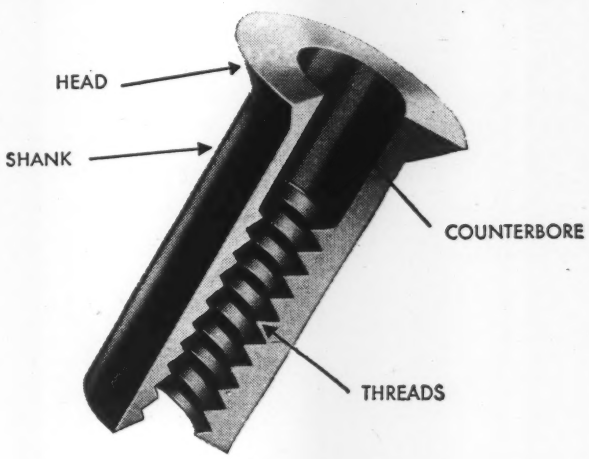


A RIVET WAS NEEDED for doors of metal cabinets that 1) could be installed from one side only, 2) would serve as a nut plate for a knob attachment, and 3) could be installed after enameling. A B. F. Goodrich Rivnut proved the perfect answer.

A flat-head Rivnut is inserted in the sheet metal door. Working from one side, one man can upset Rivnut in 2 seconds with easy-to-operate heading tool. Bulge formed in Rivnut shank grips the metal tightly. The knob of the catch is then threaded into the clean, still-intact Rivnut threads. Rivnuts are installed after enameling without marring the finish.

This simple solution saved many man-hours on the job. If you have a fastening problem, why not put it up to Rivnut engineers? Write to The B. F. Goodrich Company, Dept. MD-64, Akron, Ohio.

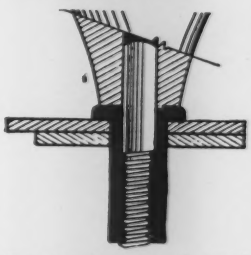
THIS IS A B. F. GOODRICH RIVNUT . . . . THIS IS HOW IT WORKS



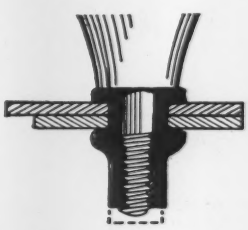
This cross-section shows the threads by which the Rivnut is threaded onto the pull-up stud of the heading tool. These threads are not injured by the heading operation and enable you to fasten *to* a Rivnut as well as *with* it.

The Rivnut provides a large bearing surface, requires only a small hole, and can be installed after enameling without marring the finish.

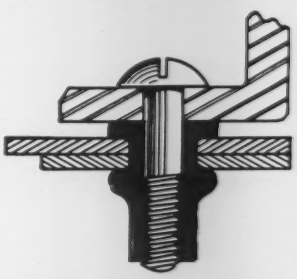
1. Rivnut is threaded onto pull-up stud of a manual or pneumatic heading tool.



2. Rivnut is inserted, head firmly against work, tool at right angles to work.



3. Tool lever operates pull-up stud, forming a bulge in the Rivnut shank.



4. After upset, threads are still clean and intact, ready for screw attachment.

B.F.Goodrich RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Shows with motion how Rivnuts work. Explains construction, gives proved applications. Write to The B. F. Goodrich Co., Dept. MD-64, Akron, Ohio.

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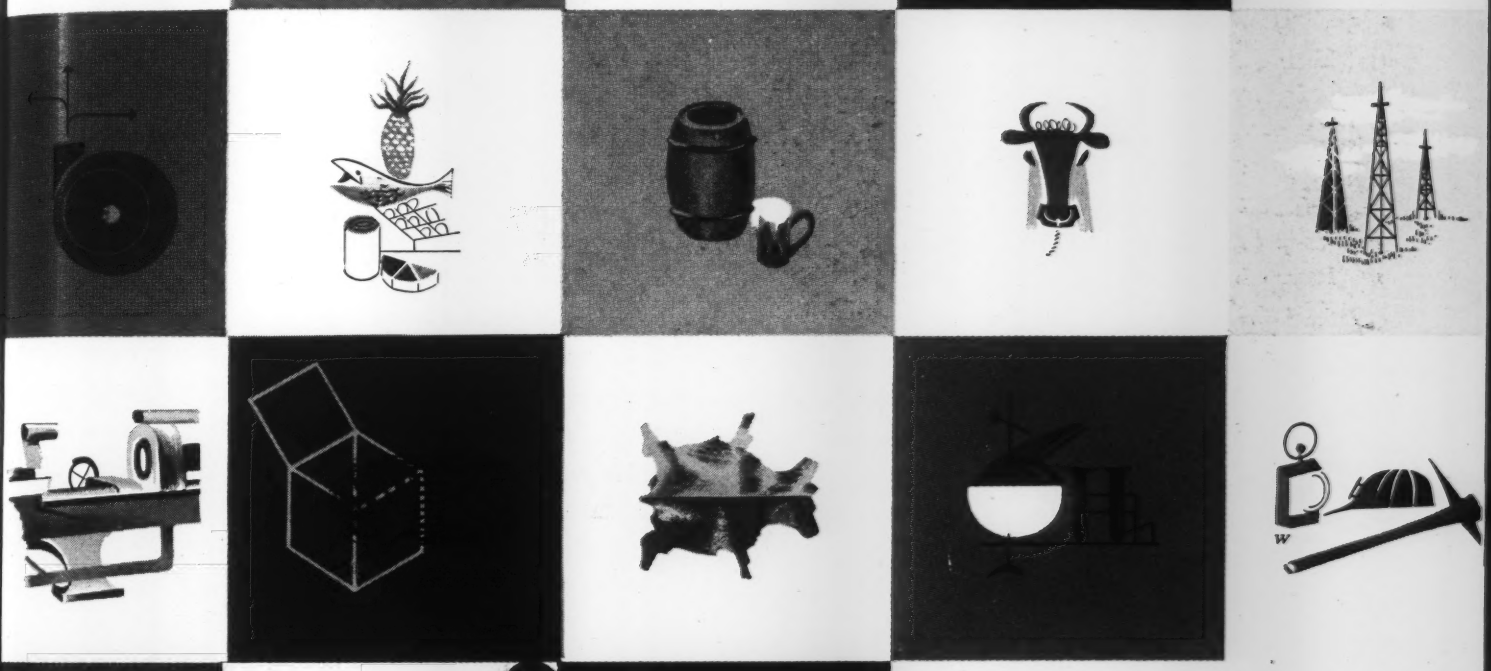

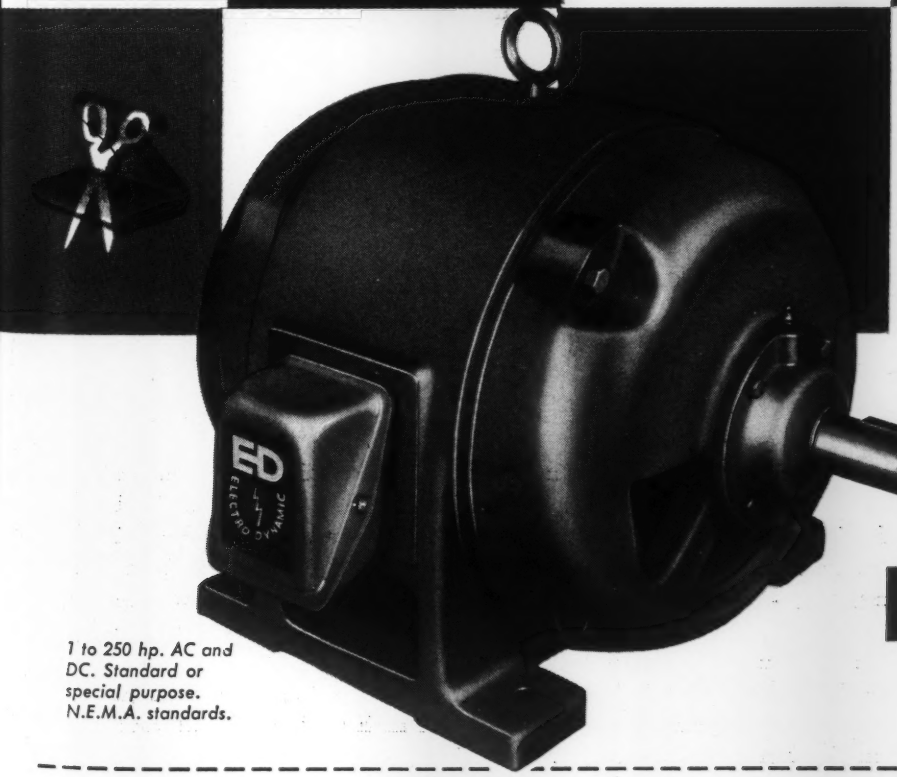

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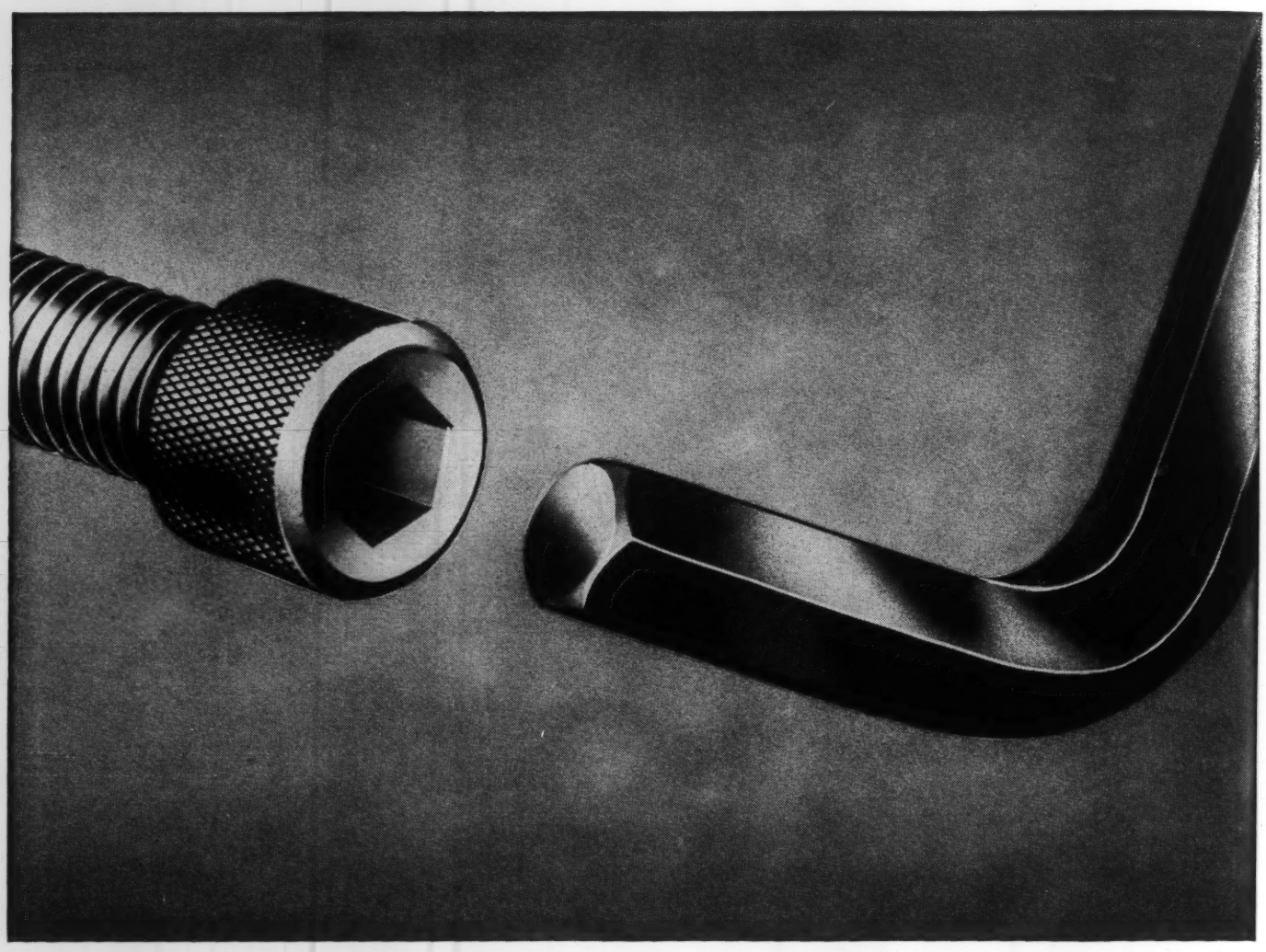


Bristol Hex Socket Cap Screws assure speedier, easier, tighter fastening

Bristol hex socket cap screws meet every production and maintenance requirement.

They spin easily into place, fit perfectly, and wrench up tightly, even in hard-to-get-at places. They take the wrench without skidding, too, so there's no danger of marring surfaces. Disassembly is just as easy. And Bristol's hex socket screws can be tightened far beyond the point where shock or vibration will loosen them.

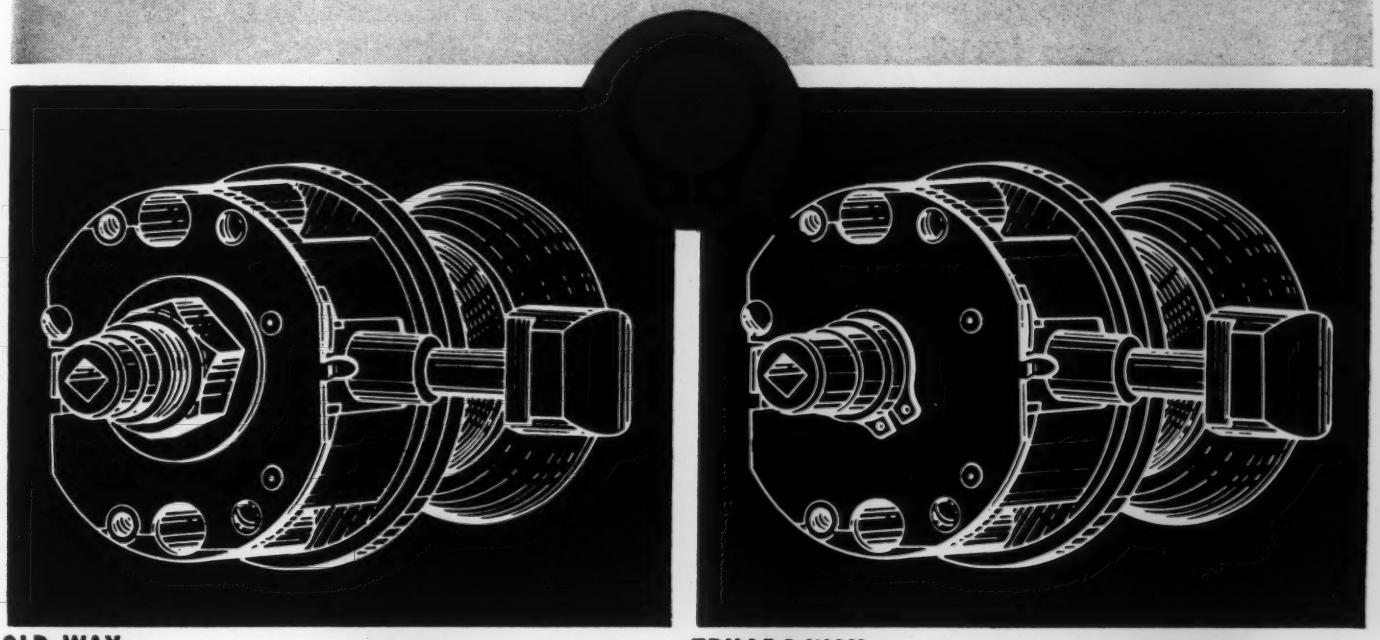
This extra holding power results from the hex socket design, and Bristol's careful control over materials and manufacturing methods. Standard hex socket cap screws are made of alloy steel specially hardened. Other special metals and finishes may also be supplied. All Bristol screws are A.S.A. approved and precision threaded either National Coarse or National Fine.

Ask for Bristol hex socket cap or set screws in sizes from 0 wire to one inch in diameter at your industrial distributor's.

BRISTOL'S SOCKET SCREWS

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Conn.

Waldes Truarc Ring Replaces Nut and Washer ...Cuts Costs $5.28 Per M...Speeds Assembly by 50%



OLD WAY. Main shaft required costly threading. Assembly was slowed by the double application of washer and nut and time-consuming tightening operation.

TRUARC WAY. Truarc Retaining Ring snaps quickly and simply over shaft. Lock assembly is secured in one fast operation. Virtually all play is eliminated from lock.

NEW DESIGN USING WALDES TRUARC RING PERMITTED THESE SAVINGS

OLD WAY

Cost of Nut	$10.00	*per thousand*
Cost of Washer	3.80	" "
Labor for Threading . . .	2.00	" "
Assembly	3.00	" "
TOTAL	$18.80	

TRUARC WAY

Cost of Truarc Ring and Grooving Operation . .	$11.52	*per thousand*
Assembly	2.00	" "
TOTAL	$13.52	

J. Chesler and Sons, Inc., Brooklyn, N.Y., manufacturers of the pre-assembled "Reddi-Mount" cylindrical lockset, uses a single Waldes Truarc Retaining Ring instead of an old fashioned nut and washer to secure the entire assembly of their lock. This new, improved fastening method enables Chesler to eliminate costly threading . . . save money on material . . . speed assembly time by 50% and produce an improved, more durable product.

You, too, can save money with Truarc Rings. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better, more economical job. Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool

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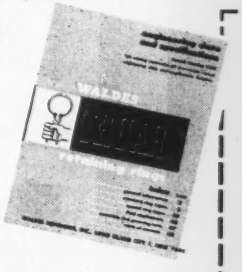

WALDES

TRUARC

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RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,420,941; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081; AND OTHER PATENTS PENDING.

MD 066

Waldes Kohinoor, Inc., 47-16 Austel Pl., L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

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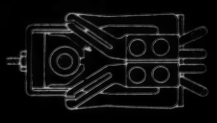
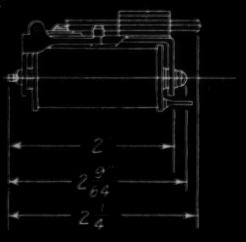
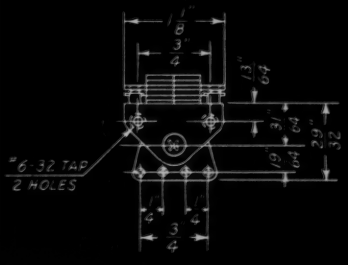
Here's a CLARE RELAY







that has changed a lot of design ideas

Compare these features of the CLARE Type J Relay with ordinary telephone-type relays

Extremely Small Size—Length: 2¼", Width: 1⅛", Height (with 10 springs): 1¾", Net Weight: 2¼ oz. (approx.).

Large Current Capacity—Rated current carrying capacity: 4 amperes, 150 watts. Twin contact points (Palladium) standard.

Exclusive New Features—Twin contacts operate independently of each other—minimize chance of contact failure.

Largest possible bearing surface for hinge-type armature.

Armature bearing pin turns in cylinder of different metal which is full width of the heelpiece.

Heelpiece designed and processed for extreme rigidity to take and hold fine adjustments.

Versatile Operation—Standard coils provide for fast operate and fast release (minimum of 1 to 2 milliseconds). Coils may be provided for time delay on operation, time delay on release, or both. Also available, double-wound coils. Operating voltage up to 220 volts d-c.

Armatures may be single (right or left) or double. Residual: lock screw (adjustable) or fixed.

Relays may be mounted on mounting bases or strips as well as upon mounting bars and individual mounting brackets. Also available with plug-in mounting.

Available with slip-on dust-tight covers or hermetically sealed in metal enclosures.

• No fully acceptable substitute has ever appeared for the conventional telephone type relay. It offers a versatility of performance and flexibility of installation that meet the requirements of the widest variety of industrial designs.

Prior to the introduction of the CLARE Type J Relay, however, designers were handicapped by the comparatively heavy weight, large size and certain operational limitations of this type of relay.

The CLARE Type J changed all this. Here, for the first time, was a light-weight, small-size relay of the telephone type. It not only gave comparable performance advantages but added certain exclusive features which offered a new conception of efficient, long-life relay operation.

This relay, among other features, provided *independent* twin contacts to preclude contact failures; the largest possible armature bearing surface, thus insuring stable operation and little adjustment change over a great number of operations; and an extremely rigid heelpiece to take and hold fine adjustments. (A fine adjustment will shift when a weak heelpiece is distorted by tightening the mounting screws.)

Acceptance of the CLARE Type J Relay has been phenomenal. It has replaced the old style telephone type relays in innumerable designs where small size and light weight were of prime importance. If you are not familiar with the features and characteristics of this relay, we invite you to contact your nearest CLARE sales engineer or write to: C. P. Clare Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address: CLARELAY. ***Write for Engineering Data Book.***

CLARE RELAYS

FIRST IN THE INDUSTRIAL FIELD

Twice Thirty-five Years of Reliability

Gust and Carl Theden, father and son, both have worked at MECHANICS for over thirty-five years.

They are typical of the father-and-son or brother-and-brother combinations at MECHANICS.

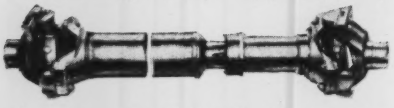
When the MECHANICS 25 year Club was organized in 1945, 3 percent of the employees were made members. By 1949 this figure had risen to 6 percent. Now, seventeen percent (one of every six) MECHANICS workers have been making universal joints the best they know how for 25 years or more.

It takes considerable Pride of Accomplishment to keep a man working at the same task for over a quarter of a century.

This devotion to an ideal is reflected in the reliable service that always has characterized MECHANICS Universal Joints.

MECHANICS
Roller Bearing
UNIVERSAL JOINTS

For Cars, Trucks, Tractors, Farm Implements, Road Machinery, Industrial Equipment, Aircraft

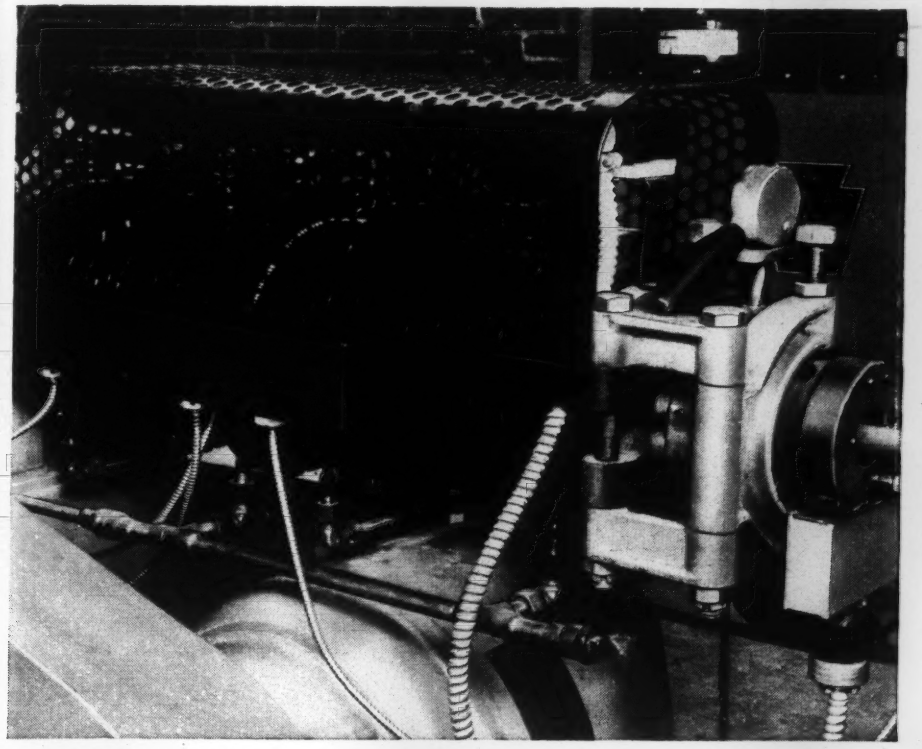


Our engineers will be glad to show you how MECHANICS Roller Bearing UNIVERSAL JOINTS will help insure the reliable operation of your product.

MECHANICS UNIVERSAL JOINT DIVISION

Borg-Warner

2032 Harrison Ave., Rockford, Ill.



ACCURATE TEMPERATURE control with Calrod heaters for this extruding machine manufactured by the Standard Machinery Company resulted in a more versatile operation.

EXCELLENT BENDING characteristics of Calrod heaters are demonstrated here. Heaters are formed to Therma-Fin mold. Pre-formed heaters are shown in background.

HEATERS ARE CAST in aluminum to assure uniform temperature during extruding process. Stainless-steel tubes for water cooling are placed alongside heaters.

G-E Calrod* heaters cast in aluminum help solve complex design problem

Standard Machinery's new Therma-Fin jacket† uses electric heat and cold water to improve extruding process

Development of the Therma-Fin jacket combining G-E Calrod heaters and stainless steel cooling-water tubing has solved a tough extruding-machine design problem for the Standard Machinery Company, Mystic, Connecticut. Prior to use of cast-in Calrod heaters, heat was often distributed unevenly in the extruding cylinder. The resulting hot-spots caused production losses.

The Therma-Fin unit, designed by Standard engineers assisted by a G-E heating specialist, provides precise control of material temperature during the extrusion process. Further, one extruding machine can handle a wide range of extruding materials because of the Calrod heater's wide temperature range. Before, separate machines were needed for each material extruded. Production is high due to fast warmup of Calrod heaters.

Standard's experience is just one more example of the many ways the complete line of adaptable G-E Calrod heaters help solve your product-design problems.

The Heating Specialist in your nearby G-E Apparatus Sales Office can help with your heating problem. Contact him today. And for the latest information on General Electric Calrod heaters mail the coupon at the right today.

*Reg. Trade-mark of General Electric Co.
†Patent pending by Standard Machinery Co.

Progress is our most important product

GENERAL ELECTRIC

NEW 1954 CATALOG!

Section E 720-123
General Electric Company
Schenectady 5, N. Y.

Please send me G.E.'s new 1954 Catalog of Calrod Heaters and Heating Devices, GEC-1005.

Name _____

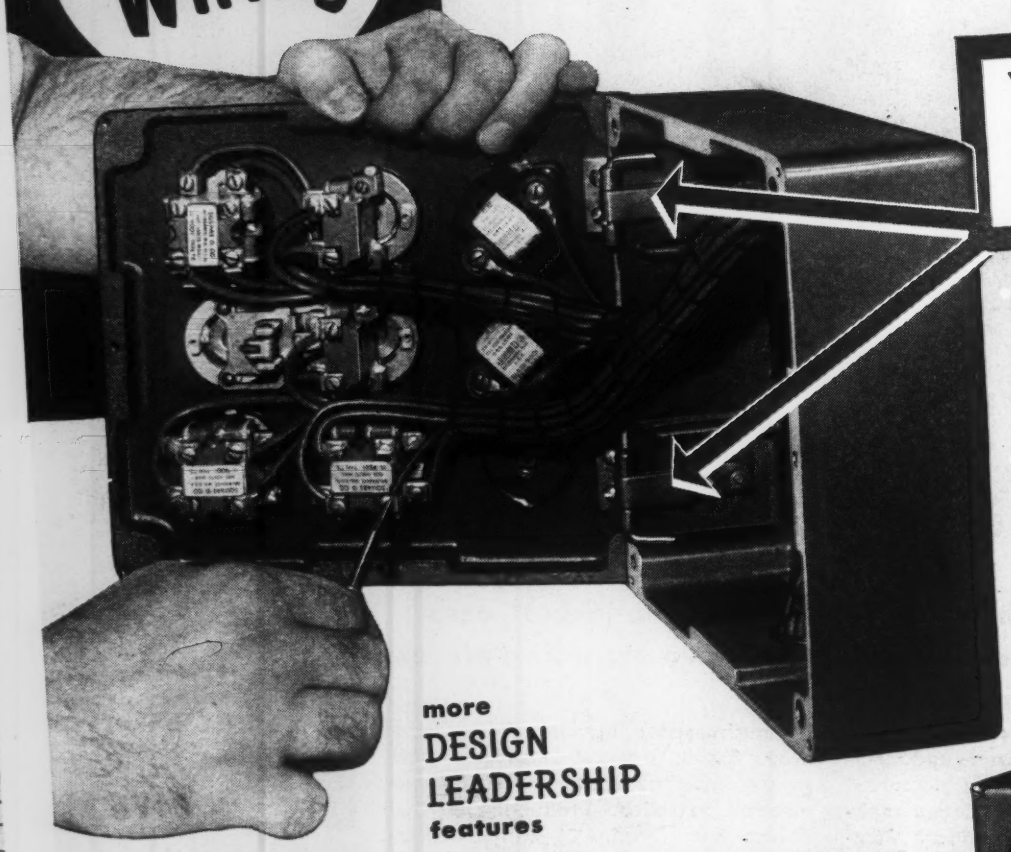
Company _____

Address _____

City _____ **State** _____

Square D OIL-TIGHT NOW FEATURE

FOR **Easier Wiring**



"Slide & Swing" for easier wiring. Hinge pins can be quickly slipped out to remove cover when installing units.

Assembly of contact blocks directly to operators eliminates alignment problems and assures proper contact overtravel under all conditions.

Ample wiring space.

Gasket-sealed mounting holes meet JIC and NMTBA standards.

Generous size bosses for conduit entry at convenient locations.

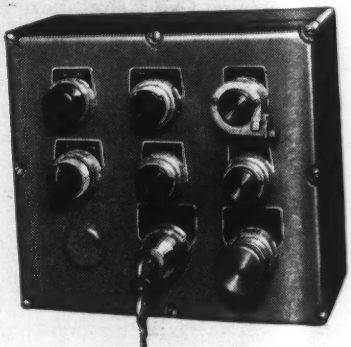
Oil-tight construction guards contacts and wiring from dust and coolant.

more
DESIGN LEADERSHIP
features

All sizes (1 to 16 units) designed specifically for machine tool service, to JIC and NMTBA specifications.

Designed to "take it." All-metal buttons. Labyrinth oil seals without diaphragms. Proved oil-tight and coolant-tight by severe tests involving millions of operations. Melamine insulation is non-carbon tracking.

Attractive appearance. Cast enclosures finished in smooth, baked enamel. Operators have new lustrous plated finish with durable protective coating.



New key-operated selector switch.

ASK YOUR ELECTRICAL DISTRIBUTOR FOR SQUARE D PRODUCTS

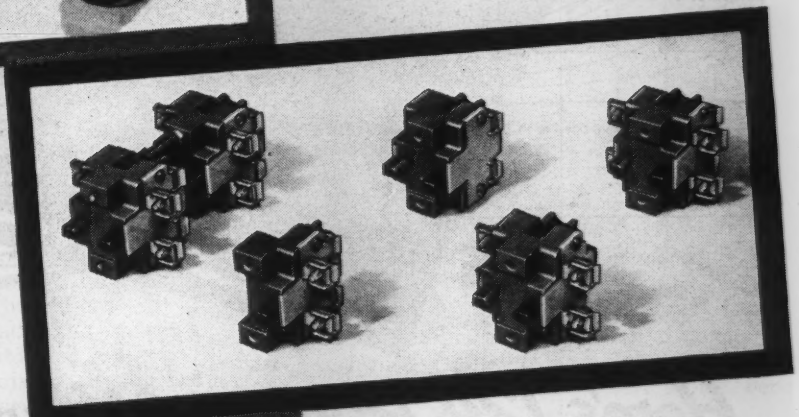
SQUARE D COMPANY

PUSHBUTTON STATIONS
"Slide & Swing" HINGE COVERS

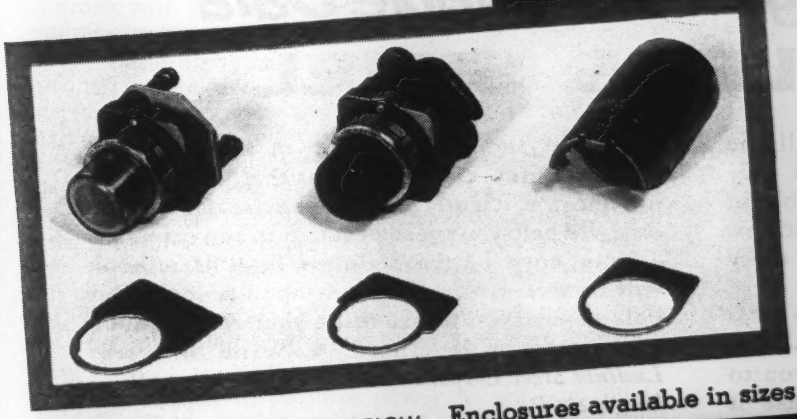
SQUARE D provides more combinations and functions with less stocking than any other pushbutton line!

Any operator combines with any contact block—a virtually unlimited selection of control functions from standard components

operators include *(top row)* locking cover pushbutton, mushroom pushbutton, standard selector switch, key selector switch. *(Bottom row)* lockout pushbutton, coin-operated selector switch, selector pushbutton, standard pushbutton, available in 7 colors.



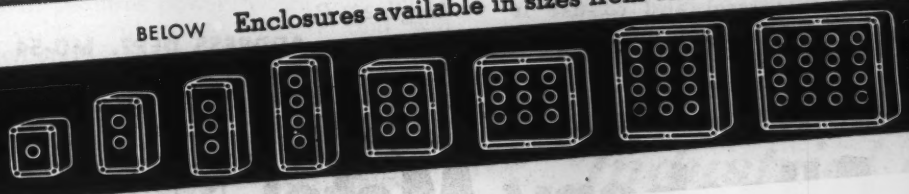
contact blocks include *(top row)* tandem duplex, duplex normally open, duplex double circuit. *(Bottom row)* single pole double throw, and duplex normally closed. Not shown is three-position duplex block.



pilot lights in 6 colors. *(Top row)* full voltage type, transformer type, assembly wrench. *(Bottom row)* Nameplates in three standard sizes.

Write for Bulletin 9001 Type T
Address Square D Company
4041 North Richards Street
Milwaukee 12, Wisconsin

BELOW Enclosures available in sizes from one to 16 units



Here's 124 Pages of Valuable Data on STAINLESS STEEL

Stainless and heat resistant steel can usually be classed as a critical material, since it not only contains strategic alloys but is indispensable in many vital industrial and armament applications. It is always important, therefore, to make every pound go as far as possible.

The latest edition of our comprehensive 124-page, case-bound Stainless Steel Handbook is ready for distribution now. It will help you to select the right stainless steel and to use it properly. Comprehensive listings of analysis, properties and characteristics of each type will guide you in specifying grades that will do your job most efficiently. Clear, concise fabrication data will help you speed production and cut waste.

Your copy of the Stainless Steel Handbook will be sent—*without charge*—upon request. Our only stipulation: please make your request upon your company letterhead. ● Write *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*

ADDRESS DEPT. MD-54

You can make it **BETTER** with

Allegheny Metal

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Warehouse stocks carried by all Ryerson Steel plants

AL® TIME-TESTED STAINLESS STEEL

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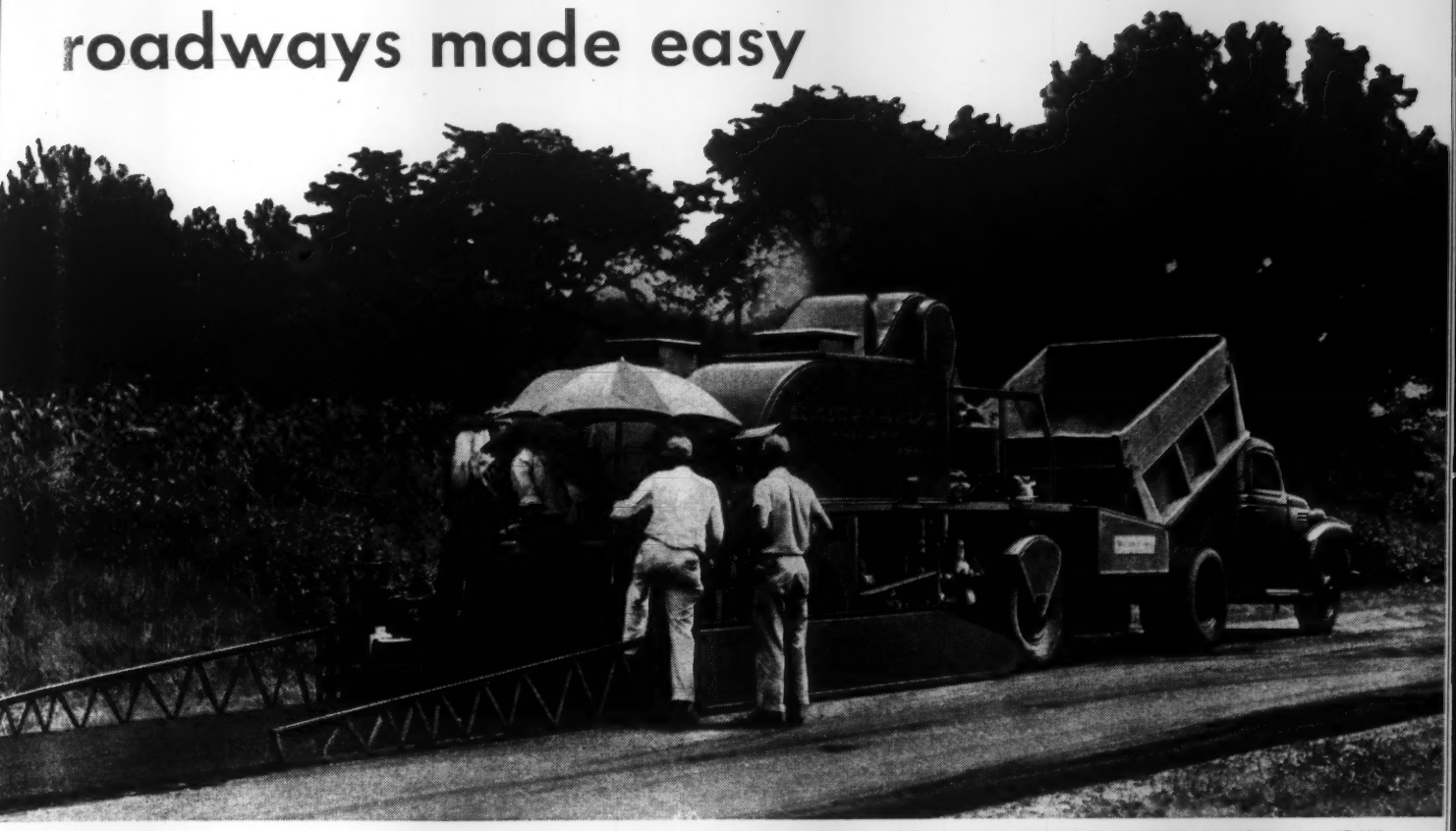


PHOTO COURTESY HETHERINGTON AND BERNER INC., INDIANAPOLIS, INDIANA

Chrysler *Power helps keep America rolling . . . at less cost*

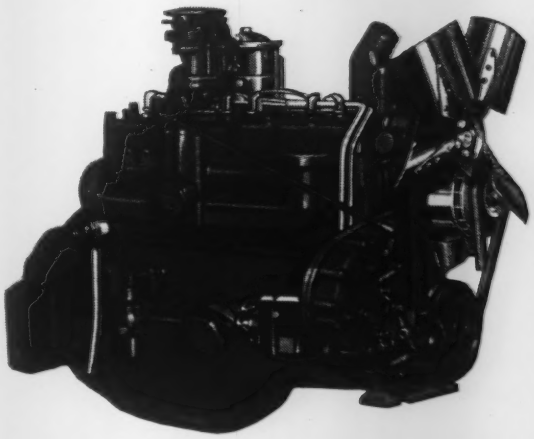
This mobile mixer-paver replaces costly man-hours with economical horsepower. In one continuous operation the unit takes in sand, gravel, stone or other road surfacing materials, mixes them in with a binder ingredient—all in predetermined proportions—and spreads the mixture onto the roadbed, to whatever depth best meets grade and crown requirements. Materials to be mixed may be fed to the unit from trucks, as in this case, or picked up from windrows with a loader attachment. The entire operation requires the services of three, possibly four, men.

The Hetherington and Berner Moto-Paver turns out up to 120 tons of mix per hour for resurfacing jobs. Paving width is adjustable from 8½ to 12 feet, depths to 7 inches. Paving speeds start at two feet per minute. Road speeds up to twenty-five miles per hour enable the equipment to carry itself from one job to another.

Two Chrysler Industrial Engines power this equipment. Travel components are driven by our Model 8 Engine whose 250 cubic inch displacement, together with Chrysler gyrol Fluid Coupling, provides power with flexibility of operation. A Model 14, powerful 331 cubic inch displacement engine, drives mixer, conveyor, spreader and pumps.

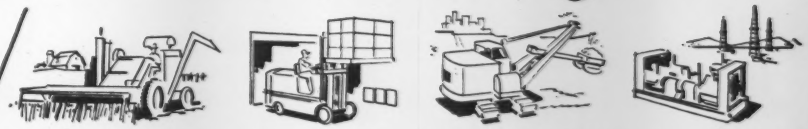
If your equipment requires power within our 230 to 413 cubic inch displacement range, engines that will operate equally well on gasoline, natural or L-P gas fuels, engines ideally suited to power take-off, see a Chrysler Industrial Engine Dealer. He can *power-fit your equipment for best performance in the field.*

Remember, too, that Chrysler Power is not expensive. Production-line methods adapted to specialized industrial engine building provide a custom-built engine at mass-production prices. If you prefer, write: ***Department 66, Industrial Engine Division, Trenton, Michigan.***



CHRYSLER *Industrial Engines*

HORSEPOWER WITH A PEDIGREE



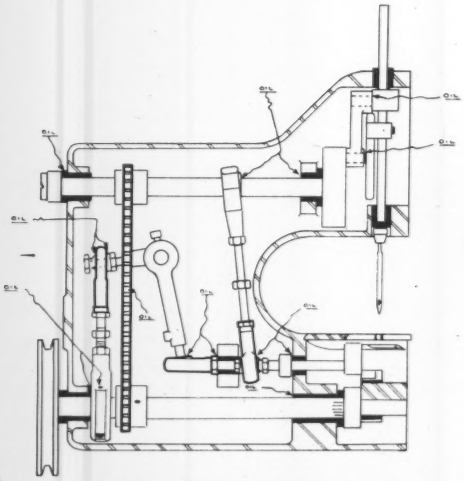
AGRICULTURE • INDUSTRY • CONSTRUCTION • OIL FIELDS

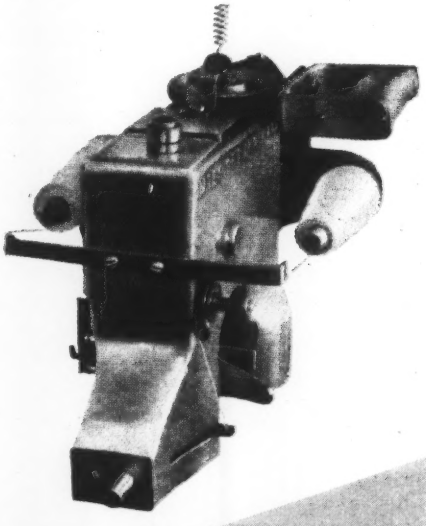
Misalignment to 25°

easily handled by HEIM *Unibal* ROD ENDS

The Heim Unibal Bearing consists of a single ball oscillating in a bronze bearing race housed in solid steel. The ball is bored through its center to accept the shaft or stud. This construction provides an anti-friction bearing which corrects misalignment in all directions.

In designing the model H-150 Portable Sewing Machine, the Minneapolis Sewing Machine Co. used three Heim Unibal Rod End Bearings in the linkage to take care of a 25° operating misalignment. On the several thousand H-150 machines in operation all over the country, Heim Rod Ends have proven highly satisfactory under every condition. This versatile Minneapolis Sewing Machine not only handles all bags (cloth, paper, and multiwall), but will sew over wrinkles, bag gathers and other impediments.





Wherever motion must be transmitted at odd and varying angles, you will find that Heim Unibal Rod Ends give maximum performance at low cost. Would you like a sample Unibal bearing?

A COMPLETE CATALOG? PLEASE WRITE . . .

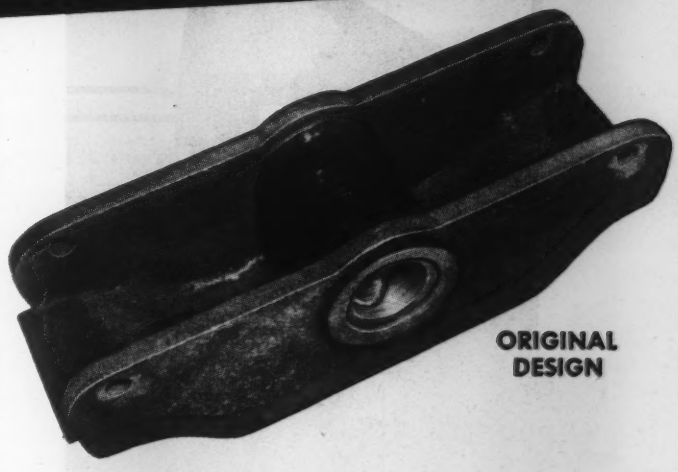
THE HEIM COMPANY
FAIRFIELD, CONNECTICUT

Case History M-124

Here's what we mean by *SUPERIOR* ENGINEERED FOUNDRY PRODUCTS...

PROBLEM:

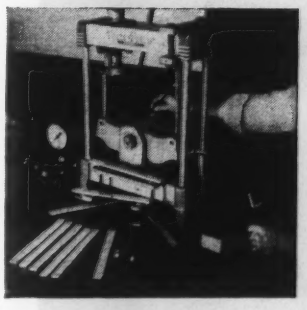
1. Reduce the cost of producing the spring equalizer for tandem axle trailer. The weldment, fabricated from four pieces of steel, required an excessive number of man hours to cut, form and weld.
2. Weight reduction was desired as this is an important factor in highway trailers.
3. Weldment was not dimensionally stable, particularly at outer ends where trailer springs ride.
4. Service failures had to be eliminated.



ORIGINAL DESIGN

SOLUTION:

Weldment was stress analyzed in Superior's own stress analysis laboratory. With the information obtained, equalizer was redesigned in cast steel by Superior's Product Development Section. Casting was stress analyzed under simulated service conditions and the redesign was refined accordingly.



RESULT:

1. Cost reduced 9.3%.
2. Weight reduction of 5 pounds.
3. Dimensional stability assured.
4. Service failures eliminated. New design effects a 68.8% reduction in stress at critical points and provides more uniform stress distribution throughout the part.

Engineering teamwork by customer and our Product Development Section resulted in a proper casting design that improved function, strength and appearance. The design assured good foundry practice, proper directional solidification of metal and production of consistently high quality steel castings.

SUPERIOR'S PRODUCT DEVELOPMENT SERVICE is here to help solve your design problems, to help save you time and money. This service develops the best design for your parts. SUPERIOR'S PRODUCT DEVELOPMENT SERVICE deals with *FACTS* not *OPINIONS*, so why not take advantage of this service to make even your BEST products BETTER.

Make your parts Superior Engineered Foundry Products . . . malleable iron castings to 300 pounds . . . steel castings to 30,000 pounds.

MODIFIED DESIGN

Courtesy Edwards Trailer Co.

Have you entered the first annual Product Development Contest sponsored by the Steel Founders Society of America? We'll be happy to send you the details.

SALES OFFICES:

CHICAGO 4, Railroad & Industrial Products Co., 332 S. Michigan Ave.
DETROIT 7, Sales Engineering Corp., 955 E. Jefferson Ave.
BUFFALO 21, Gibney-Decot Corp., 2107 Kensington Ave.
CLEVELAND 14, C. A. Lapp & Co., 1404 East 9th Street

ENGINEERED FOUNDRY PRODUCTS

SUPERIOR STEEL AND MALLEABLE CASTINGS CO.

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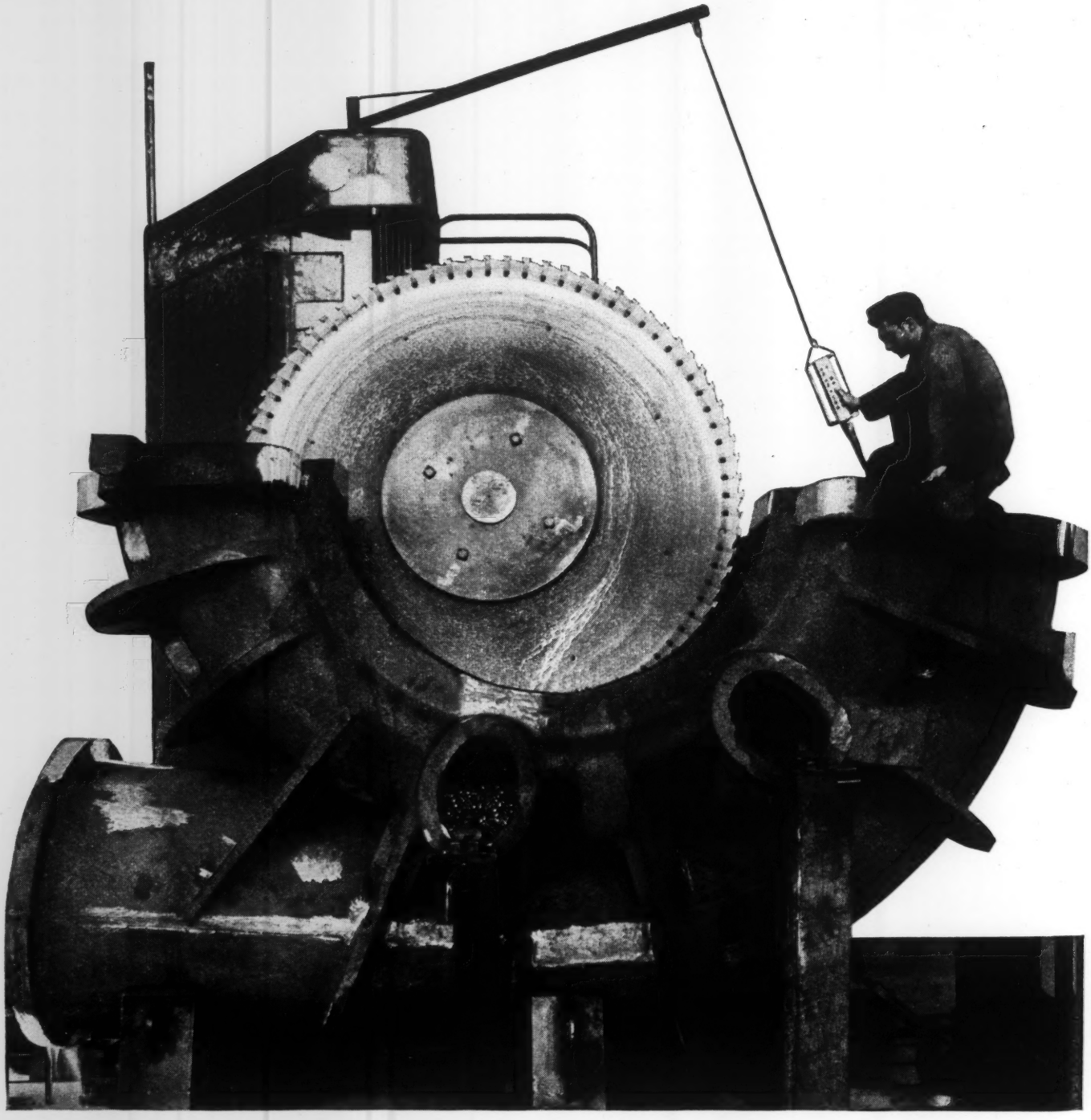
Making Good Castings for Quality-Conscious People Since 1916



Carving a 5-in. Slot in a 40-Ton Casting

This one-piece steel casting is the upper portion of a huge blower to be used in an aircraft-testing wind tunnel. It is a big casting by anybody's standards, and one that was not simple to make.

The part weighed slightly under 40 tons as cast. Specifications called for a slot 5 in. wide through 17 in. of solid steel. That's what's going on in the picture — the slotting operation. Bethlehem made the incision with a 9-ft rotary saw, which would qualify as major machining anywhere.

If your own work requires iron, steel, or bronze castings, be sure to investigate the many unusual services we offer. A Bethlehem-made casting is subject to precise metallurgical controls and careful attention to engineering details. It can be given any desired type of heat-treating. And if machining is needed, our shops can handle the job beautifully.

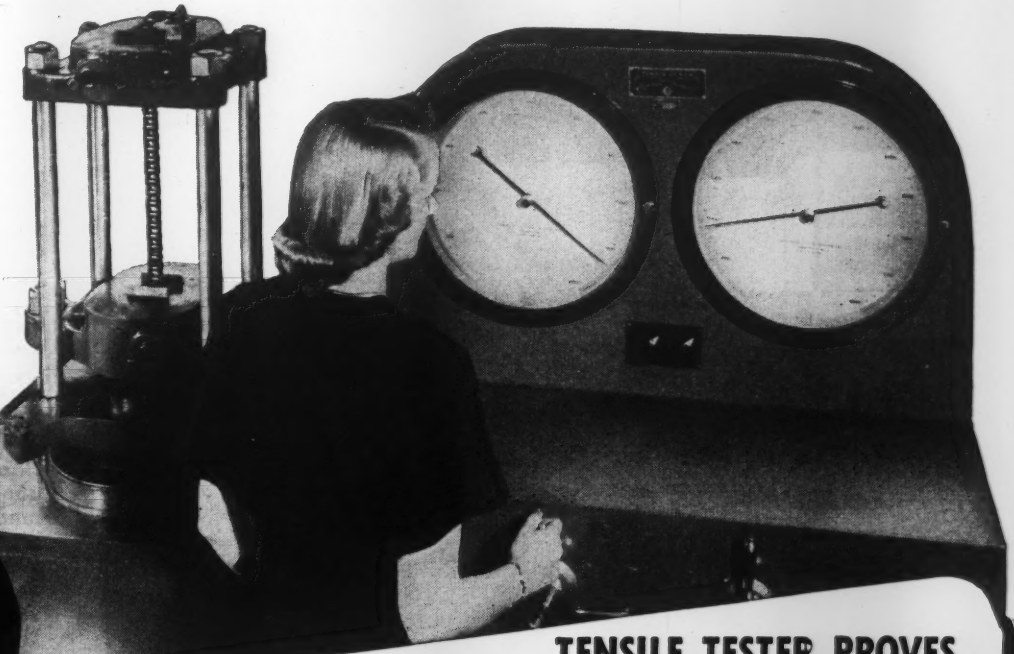
Not all Bethlehem castings are as large as the one shown here. Naturally, we're interested in the smaller kinds of work, too. But large or small, a Bethlehem casting is a *good* casting -- as good as you can buy. Why not send us your next inquiry?

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

PRE-TESTED SUPER-STRENGTH FOR *Trouble-Free* PRODUCTION



TENSILE TESTER PROVES THE EXTRA LIFE IN ATLAS ROLLER CHAIN

Tortured and torn, in tests more rugged than any you would give it in normal use, Atlas Roller Chain gives daily proof on this Tensile Testing Machine of its super-strength. You know, before you buy it, that Atlas Chain has all the strength you'll ever need . . . to stand up and take it . . . year in and year out . . . under every operating condition.

The Tensile Tester is your guarantee that every Atlas Chain drive will deliver full rated horsepower. Result . . . your machine can run at full rated speeds, with consistently greater production and lower maintenance.

For maximum load-carrying ability and longer trouble-free life, install the chain with pre-tested strength.

Write today for the new Atlas Catalog and Handbook on roller chain. Atlas "Super-Life" Roller Chain is available through leading distributors everywhere.

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NATIONAL OIL SEAL LOGBOOK

Write our Redwood City office for reprints of this Logbook page

Sealing News & Tips

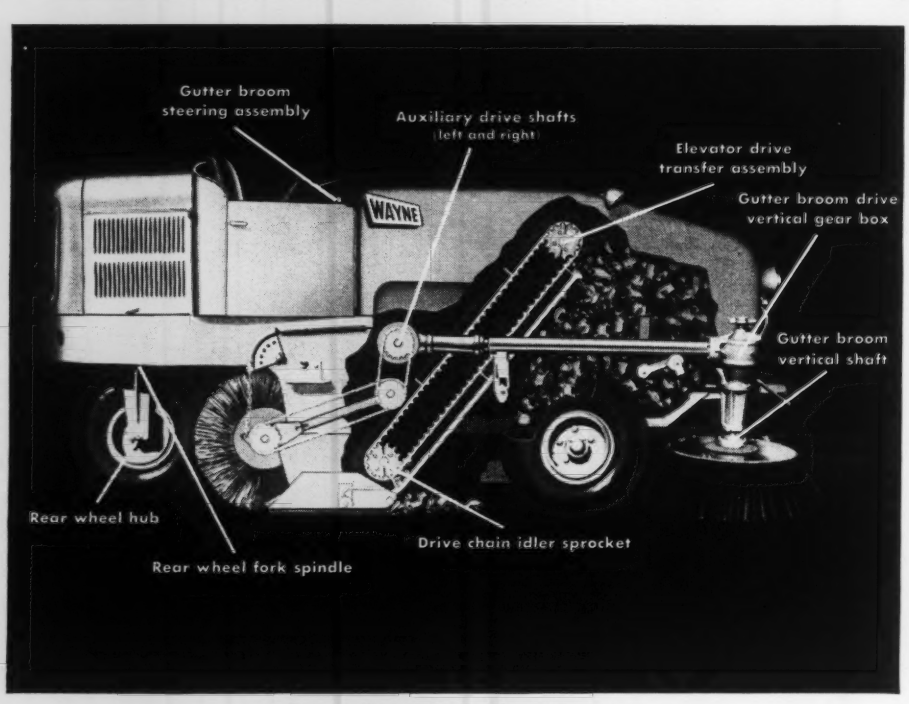

Figure 1. Wayne Motor Pick-up Sweeper

Efficient utilization of standard-design oil seals in Wayne Motor Pick-up Sweeper

Ten National Oil Seals are used at key points to insure dependable performance and durability in the Wayne Motor Pick-up Sweeper. Each seal is of different size and shape; yet each is a mass-produced, tested and proved, standard-design National seal. Careful oil seal engineering—designing with oil seals in mind—has made possible this 100% utilization of catalog seals. As a result, Wayne's original equipment seals are readily available at low cost; and identical replacements are also obtainable at any time and at low cost.

Sealing applications on the Wayne Sweeper range from the very simple to the demanding. Among the latter is the idler sprocket position at the bottom of the rubber elevator drive chain assembly (Figure 1). Here the oil seal frequently operates under extremely severe dirt and abrasive dust conditions. Other demanding applications are at the gutter broom vertical shaft bearing, where an 18" head of oil exists; and above this point in the gear box where a head of grease must be retained.

Seals used in the Wayne Sweeper are National 50,000 series with spring-tensioned leather sealing lips and rigid steel outer cases. These seals were specified from over 2,500 standard-design National Oil Seals with leather or Syntech® (synthetic rubber) sealing members. In many cases sealing problems can be solved simply and economically through use of standard-design seals; in other applications, special seals must be designed to meet special conditions. In either event, National Application Engineers are at your service. Their special skills are backed up by the world's largest manufacturing facilities devoted exclusively to oil and grease seals.

Figure 2. National 50,000 series oil seal

National 50,000-S Syntech® Seal

For continuous operation where intermittent temperatures reach 250°F, speeds reach 3,600 F.P.M. and runout is as much as .030 indicator, National 50,000-S series Syntech seals are widely used. These seals incorporate a rigid steel outer case around a spring-tensioned synthetic-rubber sealing member which is unaffected by water and most lubricants, detergents and industrial fluids.

National O-Rings

Complete line of quality, precision-made commercial grade O-Rings. Get factory-direct engineering and sales service from the National Applications Engineer nearest you, or write direct for information and new O-Ring catalog. New Catalog includes engineering and performance information, gland groove and back-up ring design requirements, etc. Request free copy on your letterhead, giving name and position.

Oil Seal Catalog

Catalog 102-A lists most National Oil Seals. Includes springless and spring-tensioned, single and dual lip, shaft and external, leather and synthetic rubber. Request your copy today from your nearest National Applications Engineer or write direct giving your name and title.

"Let Your Decision be Based on Precision"

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS

NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

3026

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DALLAS, TEXAS . . . *30½ Highland Park Village, JUstin 8-8453*
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DOWNEY (Los Angeles Co.), CALIF. . *11634 Patten Rd., TOpaz 2-8166*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . *Suite 814, 1180 Raymond Blvd., MItchell 2-7586*
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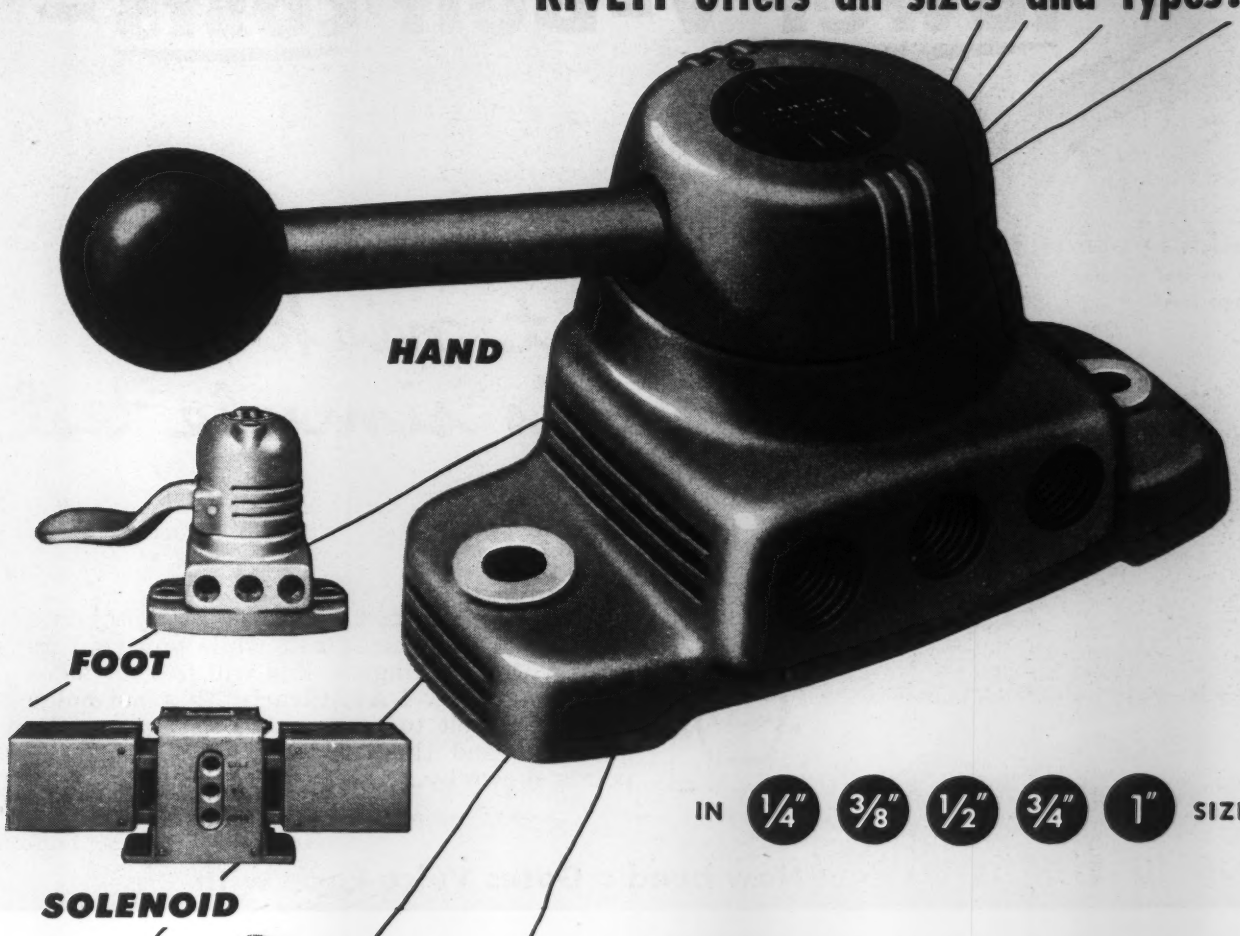
WICHITA, KANSAS . . . . *519 South Broadway, WIchita 2-6971*

AIR VALVES

RIVETT offers all sizes and types!



IN 1/4" 3/8" 1/2" 3/4" 1" SIZES

PILOT VALVES IN SIDE AND FOOT MOUNTINGS, IN PALM, PUSH BUTTON, CAM, FOOT AND SOLENOID OPERATION

You can gain more effective use of air power with Rivett air valves. Not only is there a wide selection from which to plan your circuit, but you can rely on Rivett valves to provide more dependable service.

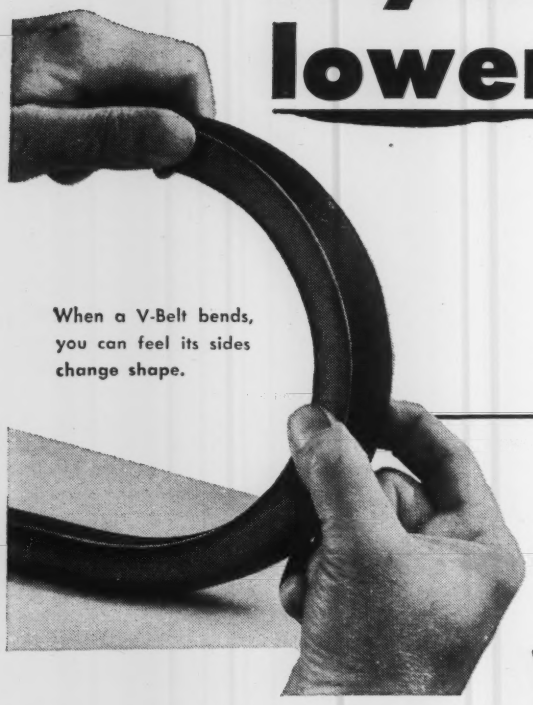
Recommended for pressures up to 150 P.S.I., these valves are designed with large, convenient pipe connections permitting unrestricted air flow.

RIVETT LATHE & GRINDER, Inc.
Department MD6, Brighton 35, Boston, Massachusetts

RIVETT **furnishes a complete power package**

VALVES • CYLINDERS • POWER UNITS
Air and Hydraulic
All sizes and types

if you want lower V-Belt costs—



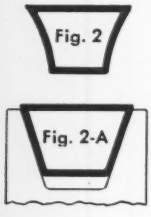
When a V-Belt bends, you can feel its sides change shape.

just make this simple test

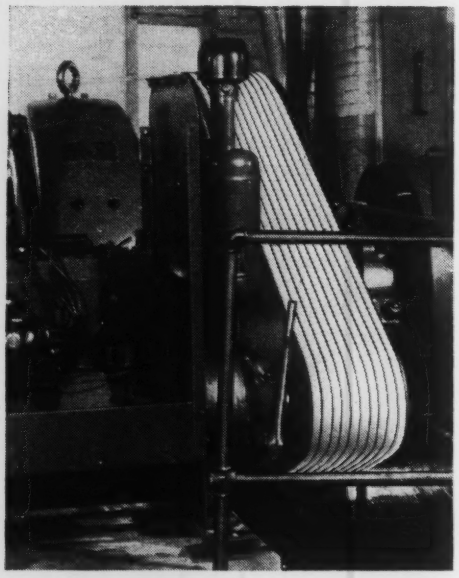
Take *any* V-belt that has *straight* sides (Fig. 1). Bend that V-belt while you grip its sides with your fingers. You will *feel* the sides *bulge out* (Fig. 1-A). Clearly, that out-bulge forces the belt to press *unevenly* against the V-pulley—and this *concentrates* wear at the points shown by arrows (Fig. 1-A).

Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2)

(U.S. PAT. NO. 1813698)



Instead of *bulging,* the precisely engineered CONCAVE SIDES merely *fill out* and become perfectly straight. This belt, when bent, *precisely fits* its sheave groove (Fig. 2-A). The sides of the Gates Vulco Rope press *evenly* against the V-pulley. Therefore, wear is distributed *uniformly* across the *full face* of this belt —resulting in *longer* belt life and *lower* belt *costs* for you!



Typical Gates Vulco Rope Drive —the Gates V-Belts are built with Concave Sides to insure longer belt wear.

When you buy V-belts, be sure to get the V-belt with the Concave Sides—the Gates Vulco Rope!

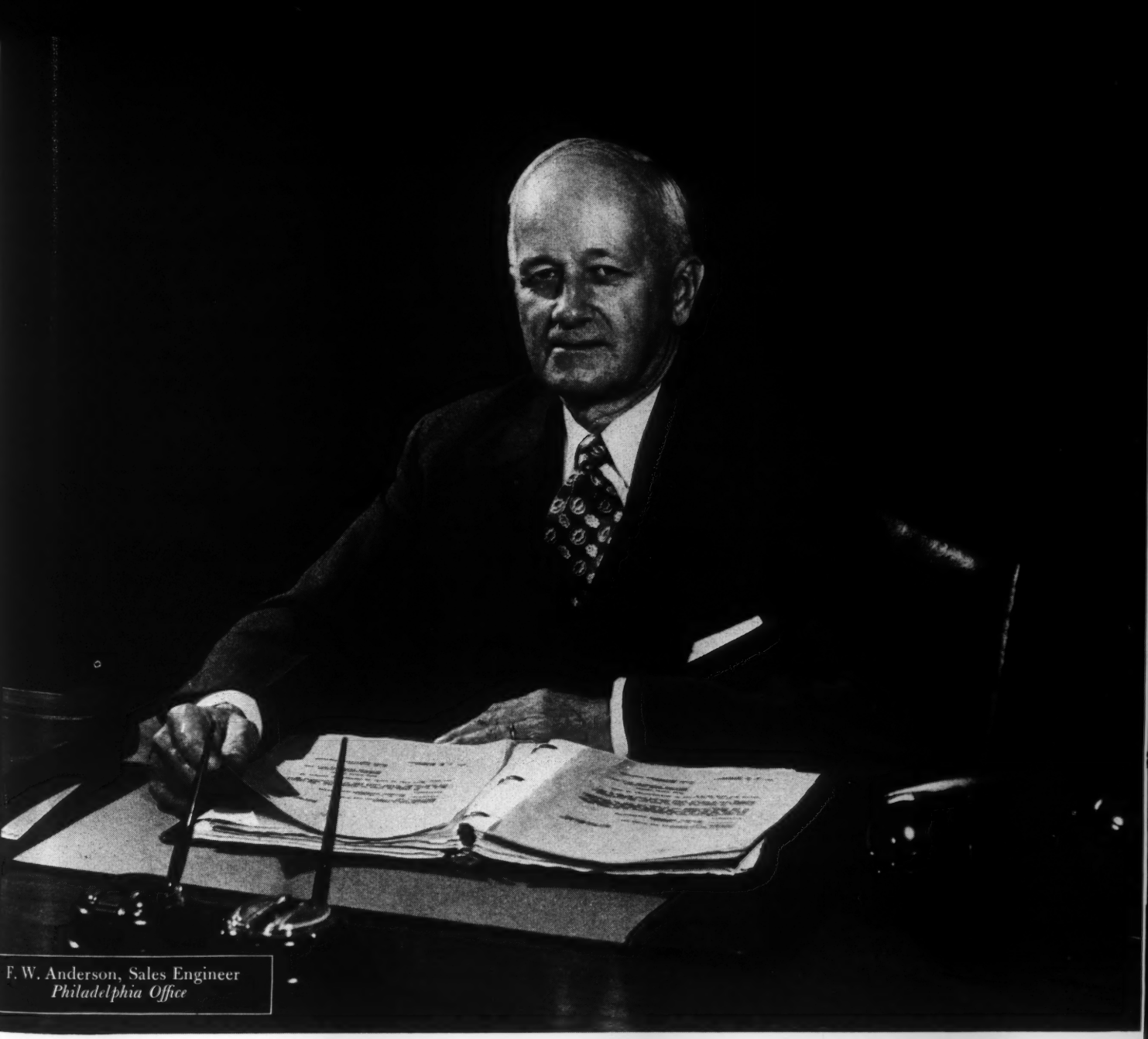
Gates VULCO ROPE DRIVES

REG. U.S. PAT. OFF.

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and Canada, and in 70 other countries throughout the world.

THE GATES RUBBER COMPANY
DENVER, U.S.A.

CS-543



F. W. Anderson, Sales Engineer
Philadelphia Office

"Holtzer-Cabot Motors Ensure Satisfaction"

"My thirty years' experience in the motor business enables me to fully appreciate the truly outstanding application engineering that goes into every Holtzer-Cabot motor. I know, too, that Holtzer-Cabot motor dependability adds greatly to a product's performance and reputation.

"Here at Holtzer-Cabot, almost every order results from a sample motor which is designed to meet the customer's individual specifications. After intensive testing by our own engineers, the sample motor is submitted to the customer for his approval. In every case, our customers have ample opportunity of 'proving out' for themselves the advantages of Holtzer-Cabot special design.

"We at Holtzer-Cabot are confident of our ability to develop special motors that give peak performance and dependable service.

"We know that our motor specialists can solve practically any motor problem given to them and that our sales representatives are thoroughly qualified by training and experience.

"If *you* have a fractional horsepower motor problem, take advantage of Holtzer-Cabot's 78 years of experience in developing special motors and related electrical apparatus to highest quality standards. Our methods and facilities are yours to command.

"Write, wire or phone. Without obligation on your part, your problem will get expert — and prompt — attention."

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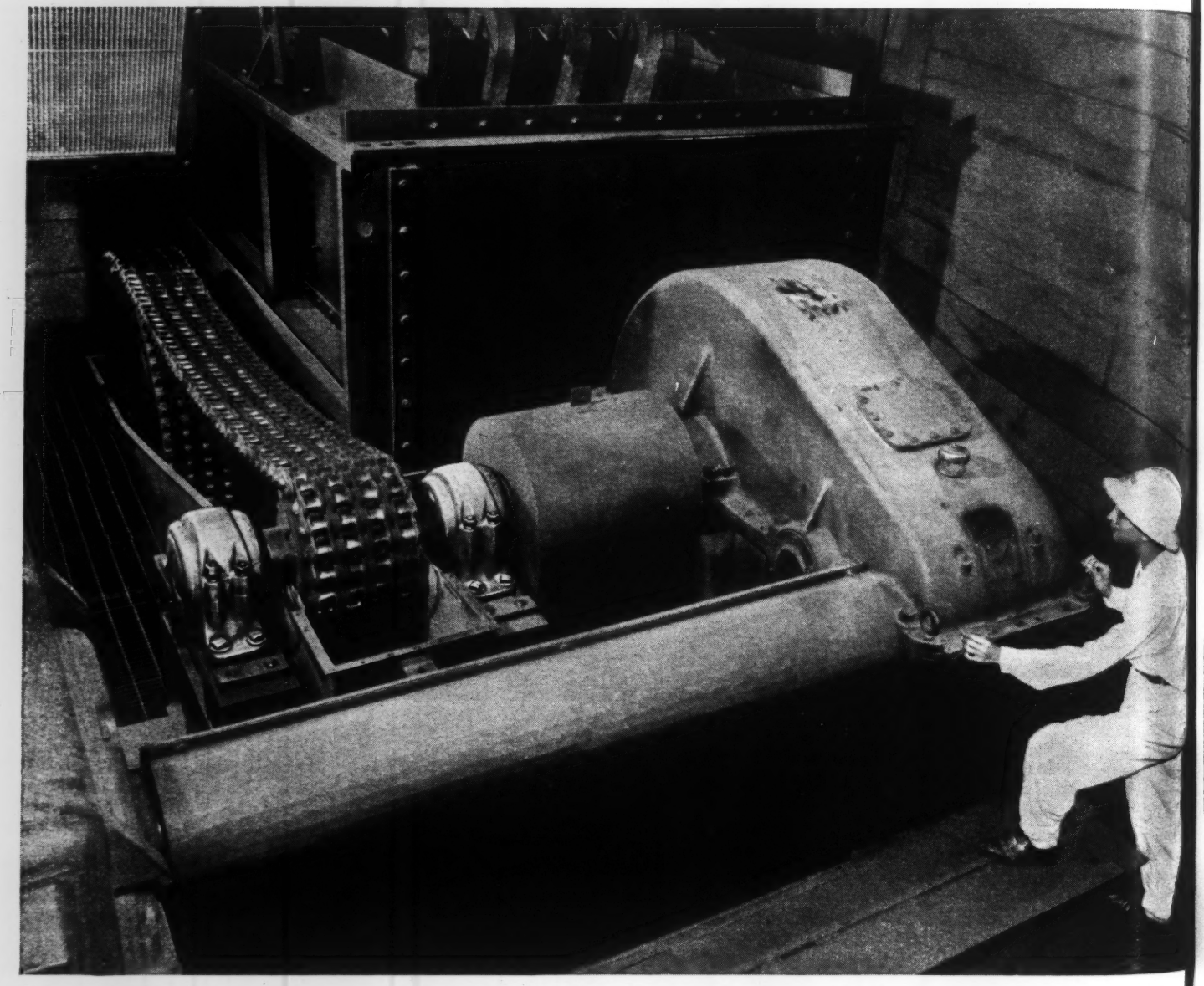
125 Amory St., Boston 19, Mass.
Sales Service Representatives
in Principal Cities throughout the World

Designers and manufacturers of mechanical, pneumatic, hydraulic, electric and electronic equipment and systems

TOUGH JOB?

Venezuelan iron ore rolls to the sea on



Roller bearing pillow blocks form part of this pre-integrated drive on the primary crusher at Puerto Ordaz. Other Link-Belt products shown include roller chain and sprockets, and parallel shaft drive, in addition to the massive 7-ft. wide apron feeder, strong enough to receive a direct load of 20 tons.

LINK-BELT

BALL AND ROLLER BEARINGS

LINK-BELT ball and roller bearings keep company with

READY ANSWER!

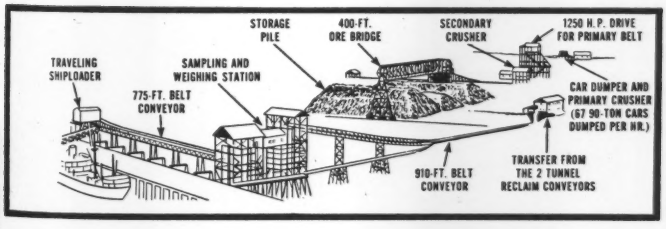
LINK-BELT BEARINGS

AT Puerto Ordaz, 545 miles north of the equator, U.S. Steel's Orinoco Mining Co. moves iron ore from mine car terminal to ocean-going ships via belt conveyors. Designed for a possible future capacity of 12,000 long tons per hour, this is the largest ore-handling system ever built at one time.

Taking the pounding of the heavy ore . . . operating day in and day out in high humidity—Link-Belt bearings are used extensively throughout the project.

You'll find Link-Belt bearings the first choice of a growing number of leading design and consulting engineers. Precision built—with ample capacity for misalignment—these bearings deliver years of high-efficiency service under the toughest operating conditions.

Next time you have a bearing problem, get in touch with your nearest Link-Belt engineer. He'll recommend the bearings that best meet your requirements from this broad, quality line.

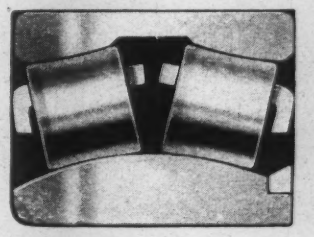


Schematic flow sheet traces the ore's movement. As prime contractor, Link-Belt fulfilled a single-contract responsibility on this huge job on which Link-Belt bearings are important components. With the excellent cooperation of sub-contractors and suppliers, engineering, fabrication and installation were completed in 23 months, five months ahead of schedule.

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.500-DE

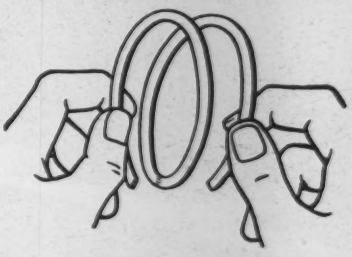
FACTS: for consulting and design engineers

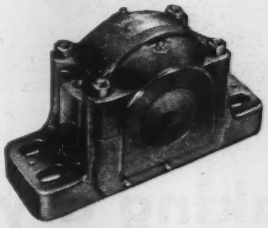
Link-Belt Series LPK-6800-F "Mill Bearings" are the answer for heavy industry. Proven Link-Belt self-aligning roller bearings are housed in steel.



FREE-ROLLING—SELF-ALIGNING—The Link-Belt "Mill Bearing" adjusts immediately in all directions, assuring full load capacity even when subjected to shaft deflections and inaccuracies of mounting. These important features enable the bearings to readily sustain heavy, sudden shock loads.

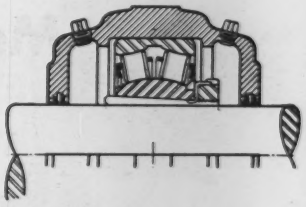
LUBRICATE WITH EITHER OIL OR GREASE—Spiral Steel seals provide effective retention of either type of lubricant. What's more, housing sealing fully protects all moving surfaces.

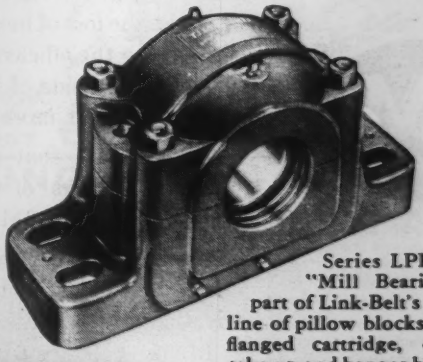




END PLATE can be used for protection where shaft terminates at the bearing. No added machining is necessary.

COMPACTNESS is achieved with self-contained design, There are no external rotating parts to mar smooth appearance.





Series LPK-6800-F "Mill Bearings" are part of Link-Belt's complete line of pillow blocks, flanged, flanged cartridge, cartridge, take-up and hanger blocks and unmounted bearings. Ask for Book 2565. For facts on the entire Link-Belt line, get Book 2550.

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Making dryers dry better

3M COMPANY

The insulation on an automatic clothes dryer is almost as important as the heat that does the drying. Effective insulation not only reduces the loss of heat from the drying area, increasing the efficiency of the dryer, it also keeps the outside of the dryer cool, making the entire unit more practical.

To be certain that the insulation stays in place, designers of the Hotpoint clothes dryer specified a 3M adhesive, EC-404.

This adhesive can be applied quickly and easily. It holds the insulation firmly in place as soon as contact is made—even on tricky, contoured surfaces. And EC-404's rubber-like film holds securely even when hot, assuring long-lasting, satisfactory service for users of the Hotpoint clothes dryer.

See what adhesives can do for you . . . If bonding together two similar or dissimilar materials is one of your problems, look to 3M for the effective and economical answer. Your local 3M sales engineer will be glad to consult with you. Call him in . . . or, write today for free informative booklet—to 3M, Dept. 196, 417 Piquette Avenue, Detroit 2, Mich.

see our catalog in PRODUCT DESIGN FILE or write for copy

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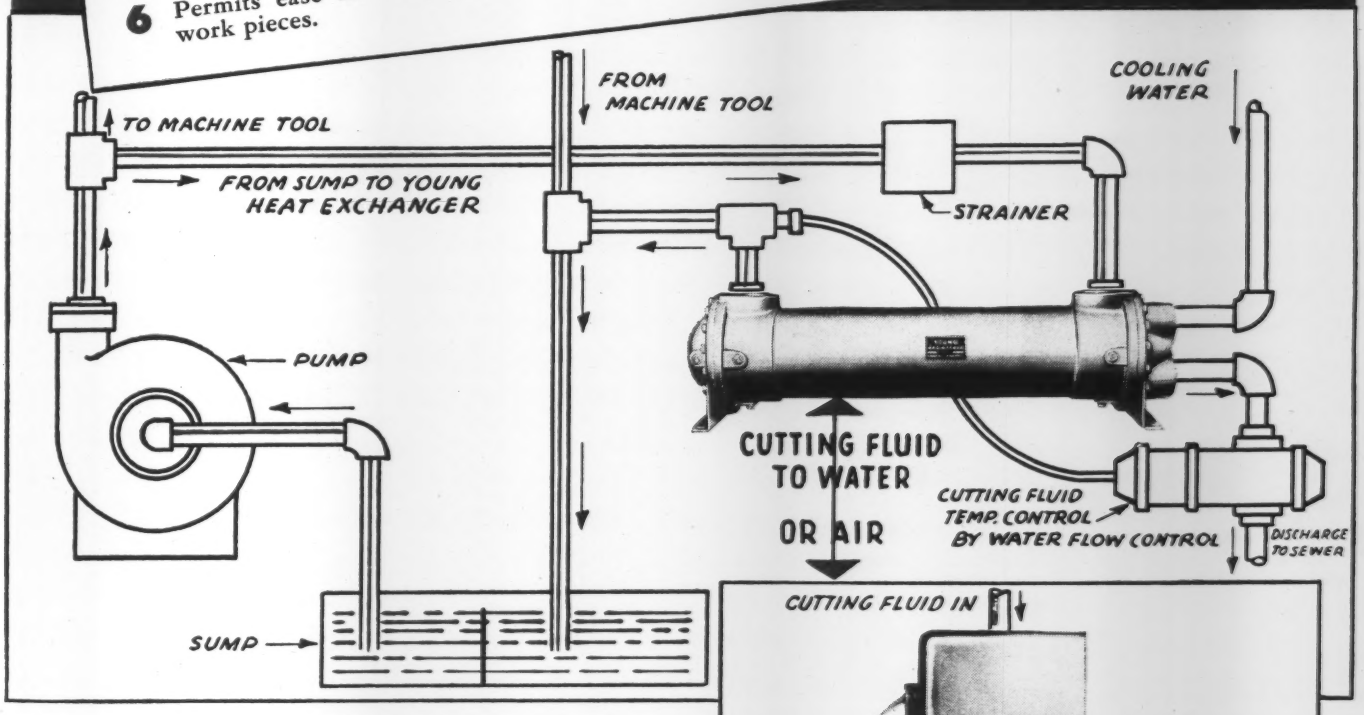
11 Reasons Why: CUTTING FLUIDS Should Be Cooled!

1. Assures uniform expansion of work piece allowing closer tolerances.
2. Eliminates non-uniform expansion of machine tool which produces excessive wear on bearings, and friction on slides, guides and ways.
3. Maintains viscosity of cutting oil.
4. Increases accuracy and convenience of gauging.
5. Reduces size of storage tank or sump.
6. Permits ease in handling because of cooler work pieces.
7. Prevents staining of tool and work piece from overheated, fortified cutting oil compounds breaking down.
8. Permits the speeding up of the machining operation.
9. Increases tool life.
10. Minimizes machine adjustment.
11. Control of run-outs.



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For Individual or Central Station Cooling

To accomplish all of the eleven advantages described above, and to provide efficient fluid cooling service, Young manufactures 690 Standard Shell and Tube Type Heat Exchangers, and 9 Standard "OSH" Type Unit Oil Coolers. These rugged Coolers, pre-tested and accurately rated, can be installed to serve individual machines or several cutting, grinding, milling or boring operations from a central cooling station. Young "OSH" Unit Oil Coolers can effect plant heating economies by utilizing waste heat to warm room interiors. For additional information, see your nearest Young Representative listed in the Yellow pages of the phone book, or write direct to, Young Radiator Company, Racine, Wisconsin.

YOUNG RADIATOR COMPANY

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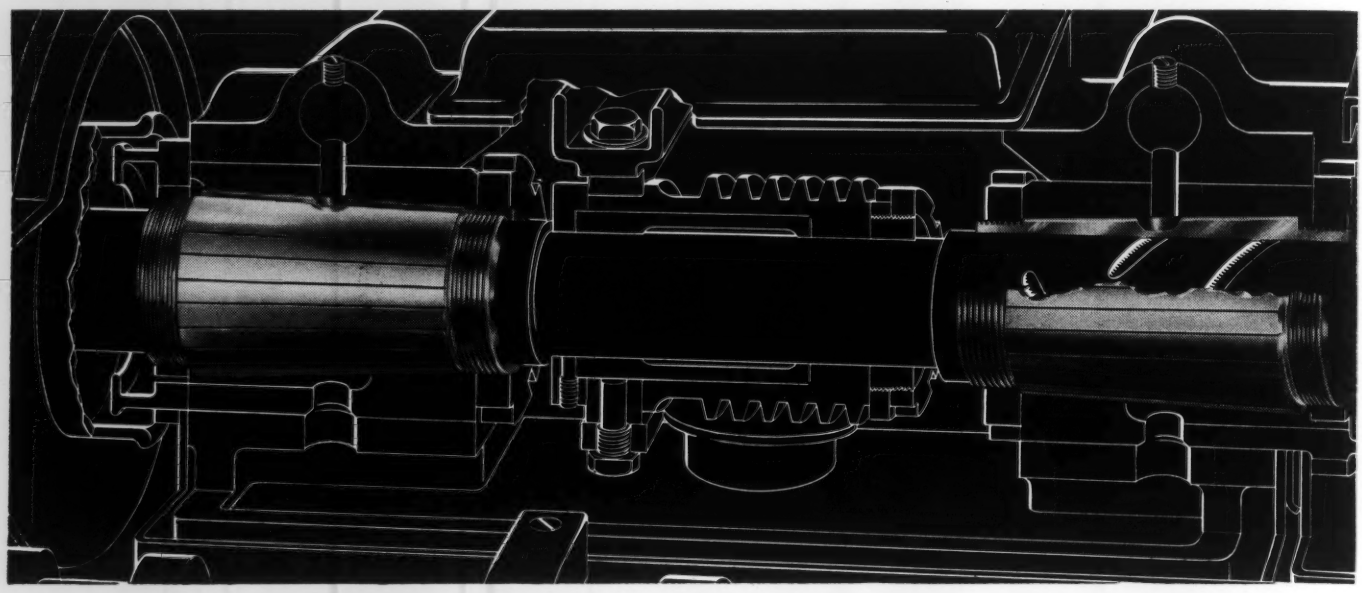
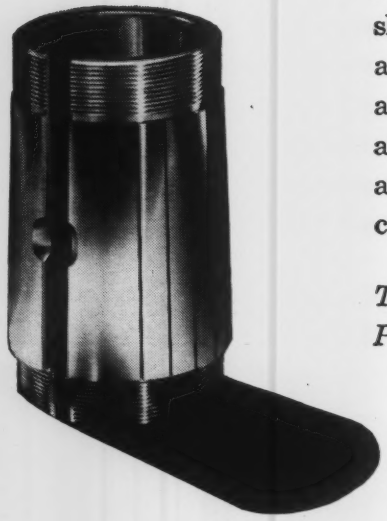


THE WAY TO CUT...

Cost of assembly

The assembly of a unit equipped with sleeve bearings is the simplest, easiest, most understandable assembly possible. After the sleeve bearing has been assembled in the housing or other part that supports it, the shaft which is to operate in it is simply inserted in the bore of the bearing. There is no inboard end cover to assemble on the shaft first, no bearing to be pressed against a shaft shoulder, no lock nut or lock washer to lock the bearing to the shaft, and finally no outside end cover or enclosure to add before the assembly is complete. Not only do these additional parts cost additional money but their preparation for assembly and the actual assembly add serious cost which you can eliminate by using a good cast bronze sleeve bearing design.



There is a Bunting Engineer near you. Consult him. Or write our Product Engineering Department at Toledo.

Bunting®

BRONZE BEARINGS • BUSHINGS • PRECISION BRONZE BARS

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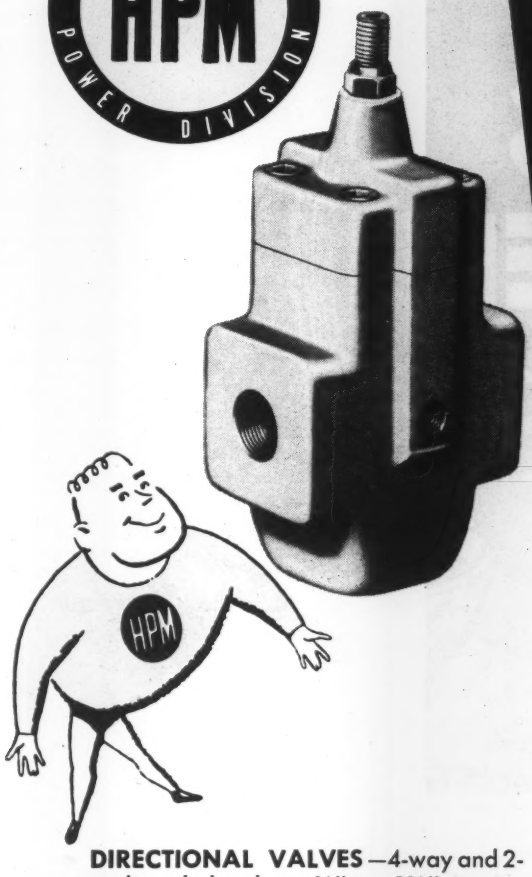
HYDRAULIC HPM POWER DIVISION

VALVES

a Complete Line



DIRECTIONAL VALVES—4-way and 2-way threaded valves, ¼" to 1½" in size for 2000 P.S.I. service • Manual, cam, foot, solenoid, oil and air pilot operation • Six spool styles • Stem, knob, lever and a new quadrant type control • Same models, types of operation and sizes also available with flange connections for 3000 P.S.I. • An equally complete line of gasket mounted valves, ½" to 4", 2000 and 3000 P.S.I. • Also rotary pilot valves • 3175 valve models with modern, improved styling for a maximum of service.

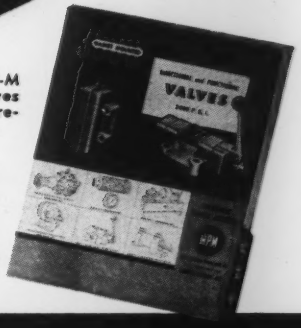
FUNCTIONAL VALVES—Relief, sequence, unloading, pressure reducing, counter-balance, flow control and check valves • Threaded connections, ¼" to 1½" sizes for 2000 P.S.I. • Flanged connections, ½" to 2½" sizes for 3000 P.S.I. • Gasket mounted, ½" to 2½" for 2000 and 3000 P.S.I. • Smooth, balanced control • Minimum pressure differential required for operation.

Write for the new H-P-M Catalogs covering Valves best suited to your requirements.

Cat. No. 801
2000 P.S.I. Threaded

Cat. No. 821
3000 P.S.I. Flange

Cat. No. 841
3000 P.S.I. Sub-Plate



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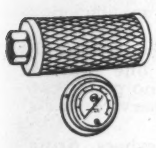
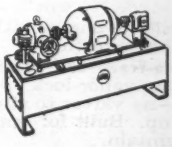
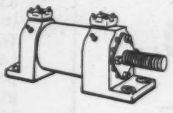


POWER UNITS



CYLINDERS



PUMPS & MOTORS

You know what you're buying when you specify HPM

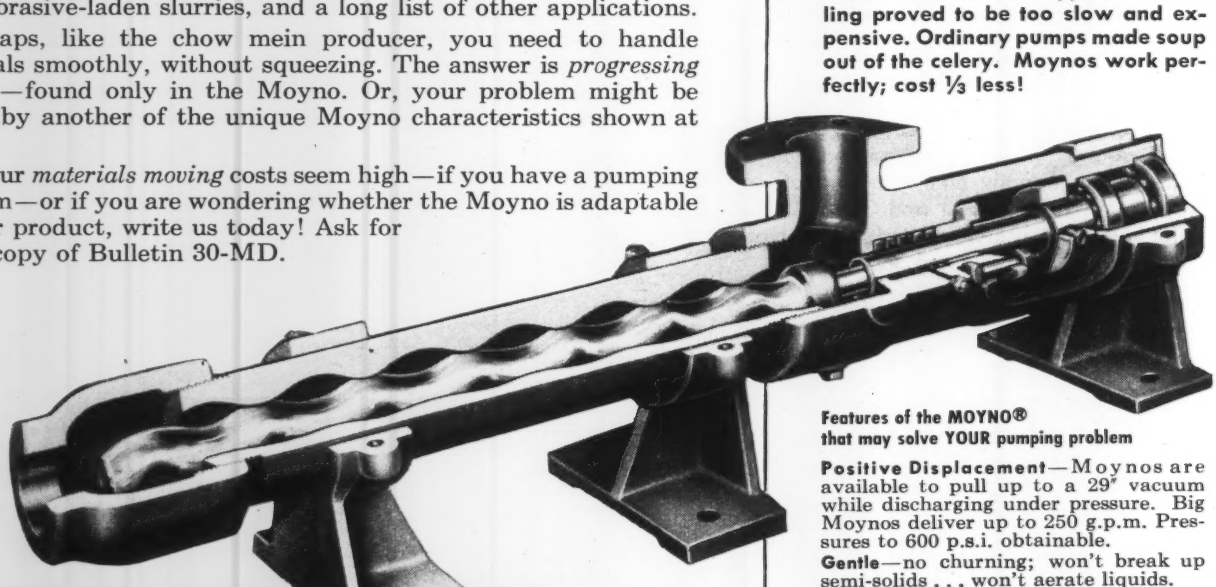
Plenty! That is, if the material you handle, like chow mein, *will go through a pipe*. If it will, the amazing Moyno Pump may be just what you are looking for!

This pump is *different*, without being a prima donna. It is *new*, yet thoroughly service-proved for liquids, pastes, solids in suspension, abrasive-laden slurries, and a long list of other applications.

Perhaps, like the chow mein producer, you need to handle materials smoothly, without squeezing. The answer is *progressing cavities*—found only in the Moyno. Or, your problem might be solved by another of the unique Moyno characteristics shown at right.

If your *materials moving* costs seem high—if you have a pumping problem—or if you are wondering whether the Moyno is adaptable to your product, write us today! Ask for a free copy of Bulletin 30-MD.

About the chow mein application: **ladling proved to be too slow and expensive. Ordinary pumps made soup out of the celery. Moynos work perfectly; cost ⅓ less!**



Features of the MOYNO® that may solve YOUR pumping problem

Positive Displacement—Moynos are available to pull up to a 29" vacuum while discharging under pressure. Big Moynos deliver up to 250 g.p.m. Pressures to 600 p.s.i. obtainable.

Gentle—no churning; won't break up semi-solids . . . won't aerate liquids.

Reversible—pumps with equal efficiency in either direction.

Trouble-Free—self priming; won't cavitate or vapor-lock. Just one moving part—no valves to stick, no pistons to gum up. Built for tough service. Easy to maintain.

Versatile—adaptable to washers, drink dispensers, gasoline pumps, oil burners, etc.—or can be custom-designed to meet your requirements.

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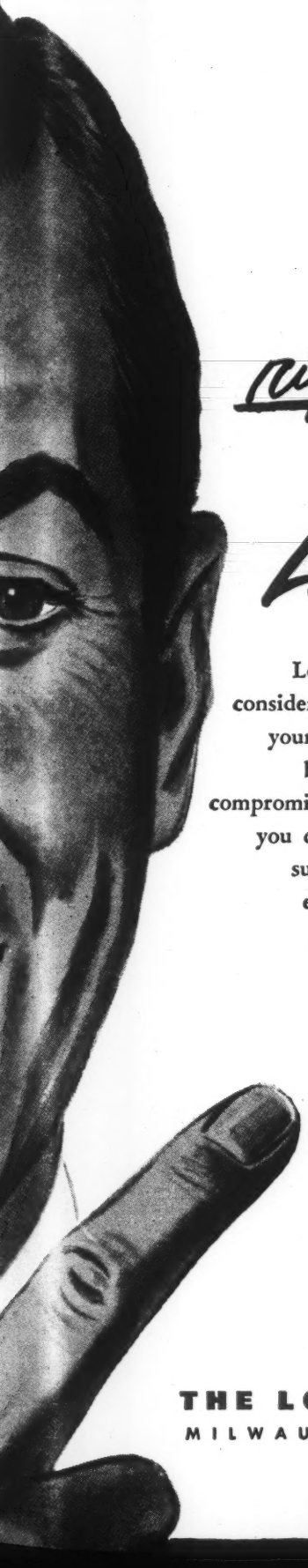
Fractional & Integral H.P. Motors & Generators | Moyno Pumps | Propellair Industrial Ventilating Equipment | Electric Fans | Electric & Hand Hoists & Cranes

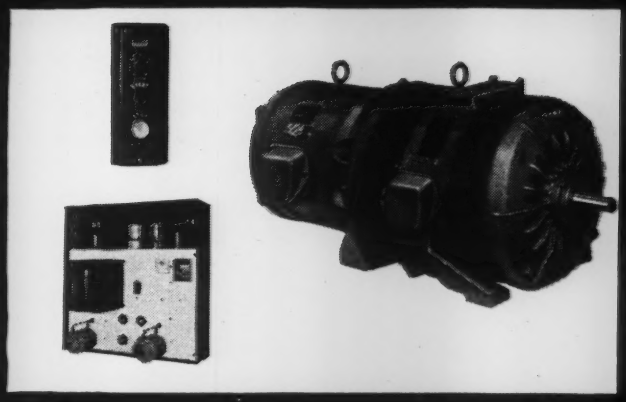


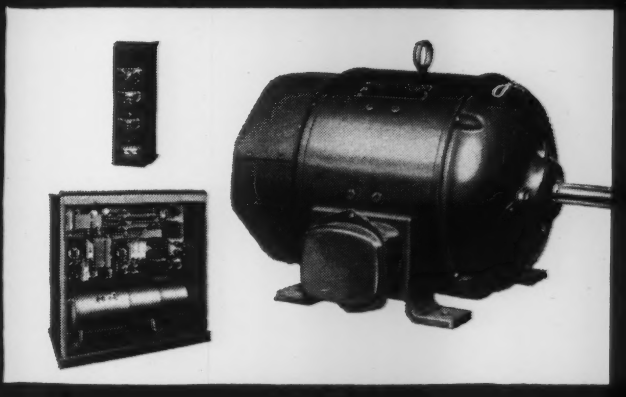
A Complete adjustable speed line

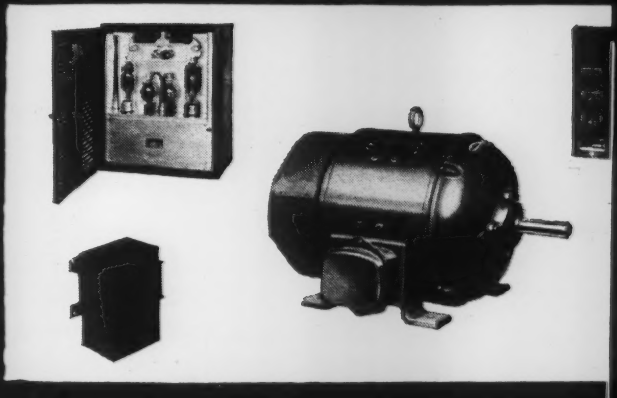
Get the right answer from Louis Allis

It pays to think first of the Louis Allis Co. whenever you're considering adjustable speed drives for your product or plant. Louis Allis builds all basic types. There's no compromising — from this complete line you can select the unit that's exactly suited to your job conditions and engineered for your application.

For the simplest — and best — solution to any adjustable speed drive problem, call your nearby Louis Allis Sales Engineer, or write to us.







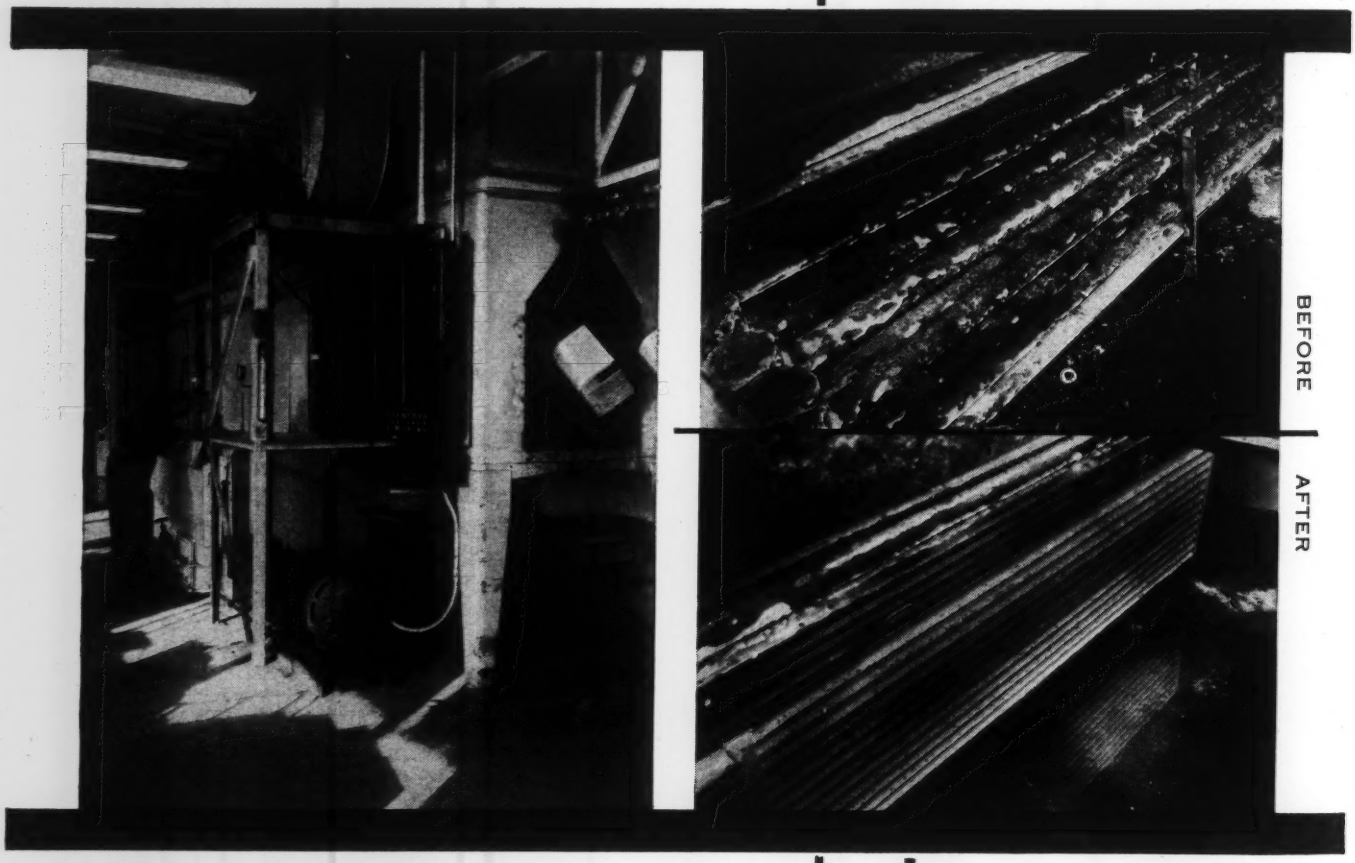
THE LOUIS ALLIS CO.
MILWAUKEE 7, WISCONSIN

ASD-101

warm-up time reduced 75% as

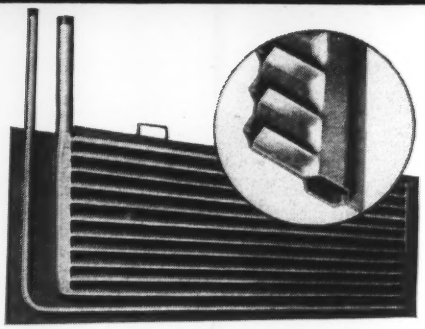
PLATECOILS *cure coil-itis**

Burroughs Corporation has reduced warm-up time in their phosphate coating system from 2 hours to 1/2 hour by replacing original pipe coils with Platecoils. They have also saved $1,440 a year in maintenance costs as the pipe coils coated badly and required chipping at least once a month while the Platecoils have required no maintenance in over a year. In addition, the Platecoils cost less to install and take 50% less space in the tank.



PLATECOILS *replace pipe coils for 50% of the cost*

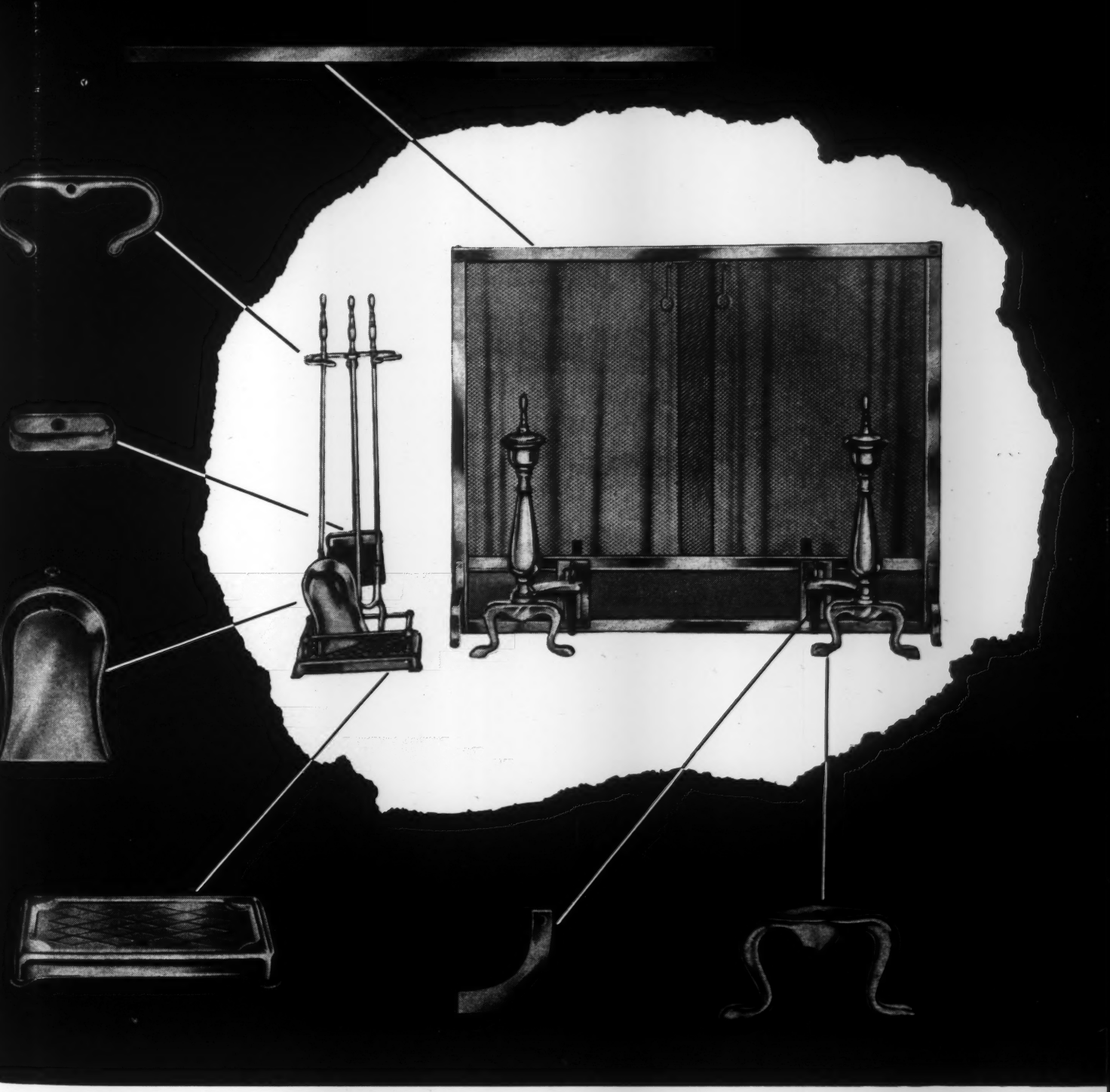
* Coil-itis is the constant doctoring of wet processing tanks for pipe coil troubles. It can be cured easily by replacing pipe coils with Platecoils. Immediately, you will notice the difference as Platecoils put new life and profits into your heat transfer processes. They heat or cool 50% faster and take 50% less space in the tank. They save as much as 50% in initial cost and 50% in maintenance costs in addition to overcoming the limitations and operating difficulties of old fashioned and outmoded pipe coils.



Bulletin P71 shows how Platecoils are replacing pipe coils at a savings throughout industry. Send today for your copy.

Platecoil Division, TRANTER MANUFACTURING, inc., Lansing 4, Michigan

For fast shipment see your local distributor



FORMBRITE'S SUPERFINE grain structure enables Special Products Co. to buff this equipment in half the time necessary with ordinary brasses.

New kind of brass called "FORMBRITE" cuts finishing costs

The bright, lustrous finish you see on this fireplace equipment – made of FORMBRITE* sheet metal – is the result of a simple color buff that took about half the time previously required. FORMBRITE's appearance after buffing speaks for itself.

FORMBRITE's superfine grain structure provides a surface far superior to ordinary drawing brasses. In every case, it's meant important savings in finishing costs . . . *and* improved product quality.

FORMBRITE is readily formed, drawn or embossed . . . results in products that are harder, stronger, "springier" and more scratch-resistant.

But don't take our word for it. Read what others say about this specially processed drawing brass:

Niagara Searchlight Corp. – "Cuts polishing and buffing time on flashlight end caps 50% . . . plating and general quality are improved, too."

Aeroplane Tackle Mfg. Co. – "We cut polishing costs over 25% . . . on several stamped products we get the required finish by a simple tumbling before lacquering or plating."

Sheaffer Pen Co. – "Savings in polishing costs are as high as 50%. Formbrite gives us a longer-lasting product."

Yet with all the plus values FORMBRITE offers over conventional brasses *it costs no more.* You can do it better, faster and cheaper with FORMBRITE. Want a sample? More information? Write: *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.* *Reg. U. S. Pat. Off. 5483

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FOOTE BROS. Enclosed Gear Drives

It takes plenty of muscle to meet industry's demands for sure, dependable power transmission . . . rugged design, trouble-free operation, high load-carrying capacity, top efficiency and longer life. This is the kind of service industry expects—*and gets* from Foote Bros. Enclosed Gear Drives, day after day, year in and year out.

In the famous, job-proven Foote Bros. line of enclosed gear drives, you will find a wide variety of sizes and types to meet any industrial service. See Foote Bros. *first* . . . for performance you can measure, quality you can trust.

WRITE FOR COMPLETE DETAILS . . . on how Foote Bros. Enclosed Gear Drives can meet your needs for toughest daily service. Write today!

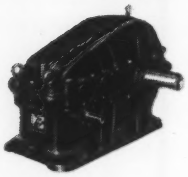
HYGRADE DRIVES

Horizontal and vertical types. Vertical available in Hytop design with long, unsupported output shaft extension. Single, helical-worm (illustrated)and double-worm reductions in ratios up to 4108 to 1; capacities up to 260 h.p.

FOOTE BROS.

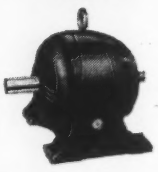
Better Power Transmission Through Better Gears

Manufacturers of Duti-Rated Lifetime Gears, standard gears, enclosed gear drives of all kinds, gear motors, aircraft-quality gears and actuators, and special machinery . . . the world's finest since 1859.



MAXI-POWER DRIVES

Compact housings, specialized heat-treatment for gearing and improved accuracy of gear tooth generation mean longer, trouble-free performance. Ratios up to 360 to 1; capacities up to 1550 h.p.



LINE-O-POWER DRIVES

Incorporate higher capacity, space saving, longer life *Duti-Rated Lifetime Gears.* Available in double and triple reductions with ratios from 5 to 1, up to 238 to 1; capacity range from 1 up to 200 h.p.

FOOTE BROS. GEAR AND MACHINE CORPORATION • 4545 SOUTH WESTERN BOULEVARD • DEPT. O • CHICAGO 9, ILLINOIS

Design to cut your own assembly costs, and you'll design to beat competition

WESTINGHOUSE CAN CONTRIBUTE . . .

Page in Insert

EASIER MOTOR MOUNTING

NEW LIFE-LINE "A" MOTOR 2
LIFE-LINE d-c MOTOR 2
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GEARMOTORS AND GEARING PRODUCTS 4

A FULL LINE OF CONTROL DEVICES

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RELAYS 6
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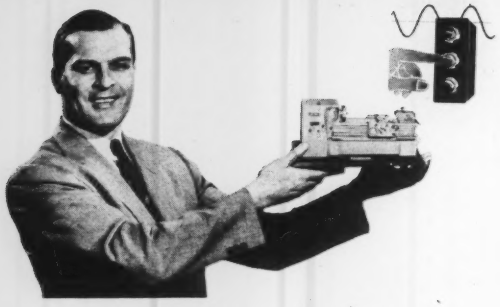
OTHER COMPONENTS 7

ENGINEERING, MANUFACTURING AND REPAIR SERVICES . . 8



Simplify machine assembly with these two drives

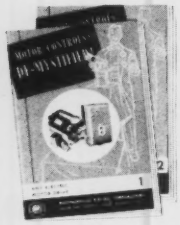
Life-Line® Motors

One of the biggest time wasters—both in designing and in producing equipment—is providing for motor greasing. The new, pre-lubricated, Life-Line "A" Motor does away with the problem completely. Install Life-Lines in close quarters, too, or in hard-to-get-at locations—and then forget them. Just the right amount of life-tested grease is pre-packed at the factory in labyrinth 4-way seal bearings.

New Life-Line "A" Cast Iron Motor is smaller, lighter than conventional motors, rating for rating, and provides more horsepower in a given frame than ever before. So, it's more quickly and easily built into equipment interiors, can give you more compact machine design, or provide increased ventilating room where desired.

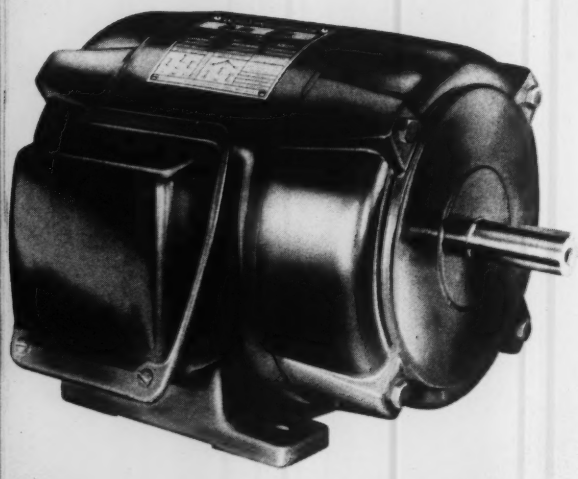
Life-Lines provide more mounting flexibility—they're drip-proof in any position because there are no openings in the frame. They're better protected with the new 4-way bearing seal and new armorized enclosures. They're smoother, quieter in operation with improved design.

The most advanced design in motors available anywhere is yours in Life-Line.

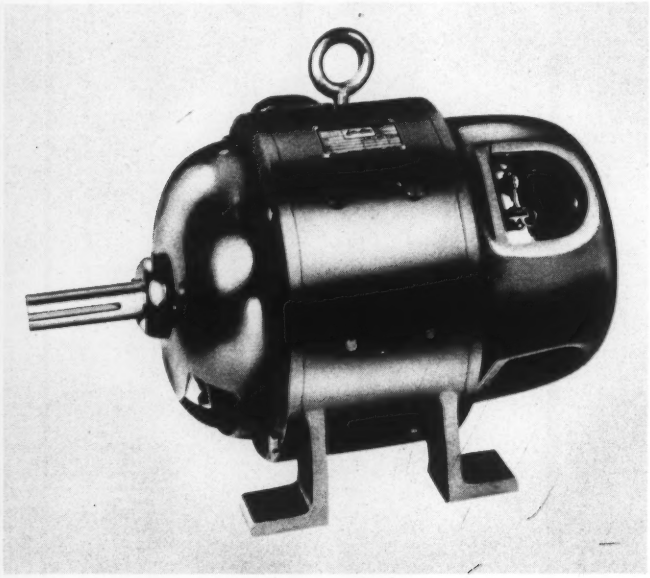


Controls De-mystified

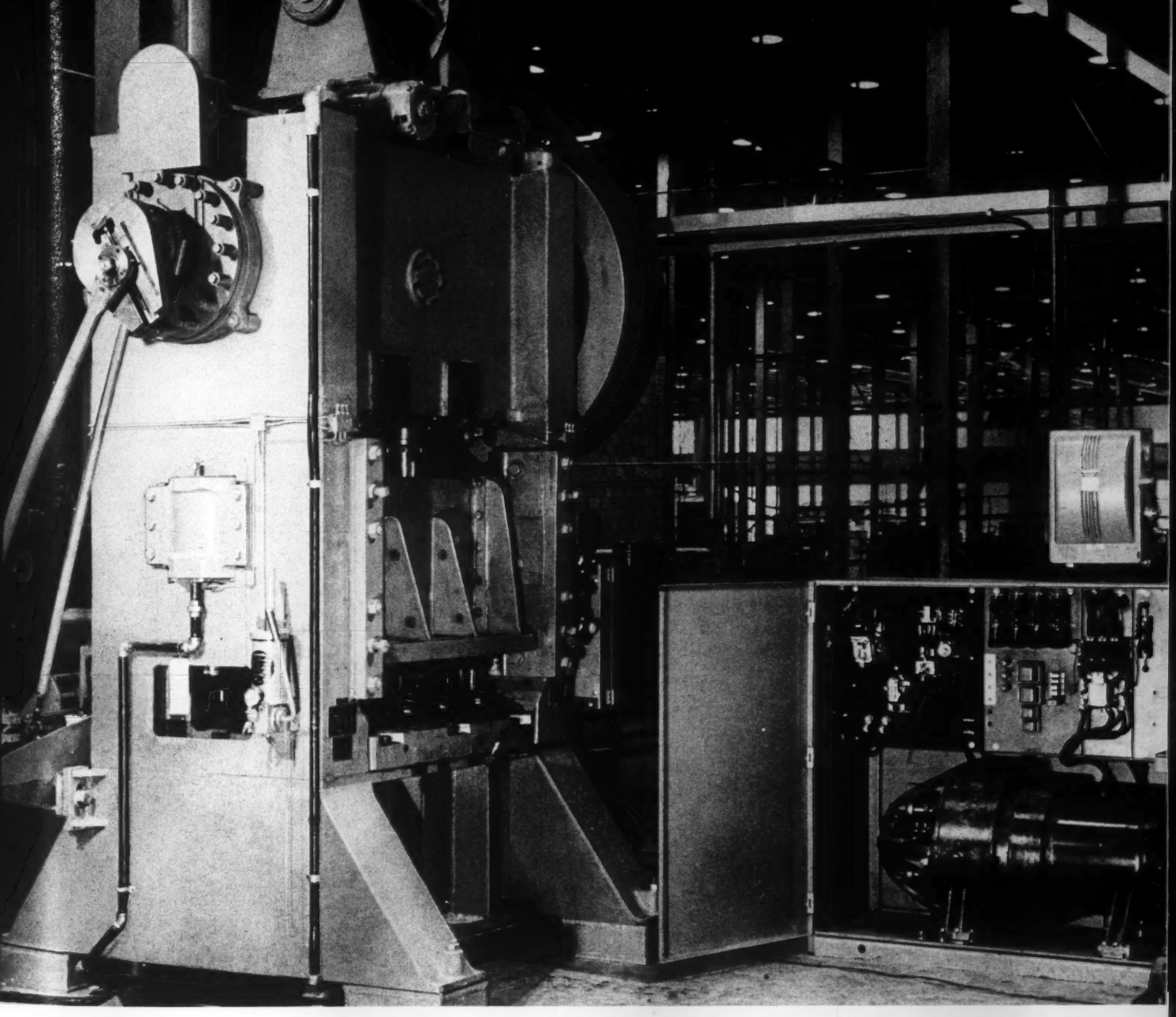
A new series of sound-slide films on modern systems of motors and controls is available through your Westinghouse representative. These films will help with problems in the application and selection of control components and their functions.



New Life-Line "A" Cast-Iron Motor gives you all the proved-in-service features of Westinghouse motors *plus* extra protection, greater application flexibility, and smoother, quieter operation.



Life-Line SK d-c Motor provides easier installation into machines because of pre-lubricated bearings, requiring no greasing channels. A full line of SK motors is available for any equipment requirement.



More compact, more economical power with Westinghouse AV Drives

Space saving? You bet. Here is a power package that in one compact enclosure gives your customer a complete, variable-speed, d-c power package containing a motor, generator set and all necessary controls. It provides on-the-spot conversion from a-c power lines without the necessity of intricate d-c plant feeders. D-c distribution equipment is more expensive and more trouble than a-c—in initial cost, installation and maintenance.

Assembly onto your tools is simpler—AV Drives come completely engineered in enclosures, ready for hook-up. They help you in other problems of special function, too—components are easily added for automatic sequencing, speed, acceleration, deceleration, dynamic braking, and so on.

So, for more compact, laborsaving, easy-to-apply, variable speed power, specify Westinghouse AV Drives.

YOU CAN BE SURE...IF IT'S Westinghouse

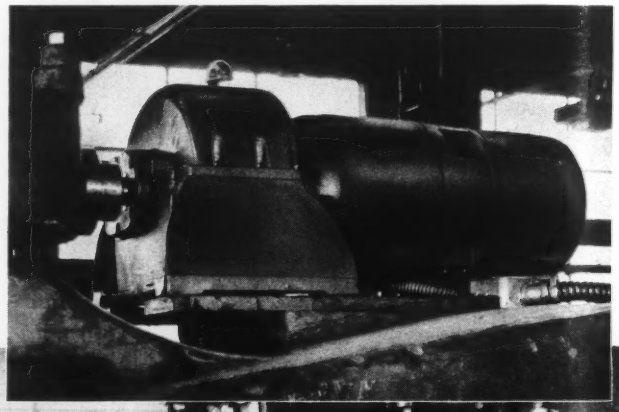
Speed mounting, alignment with compact Westinghouse Gearmotors

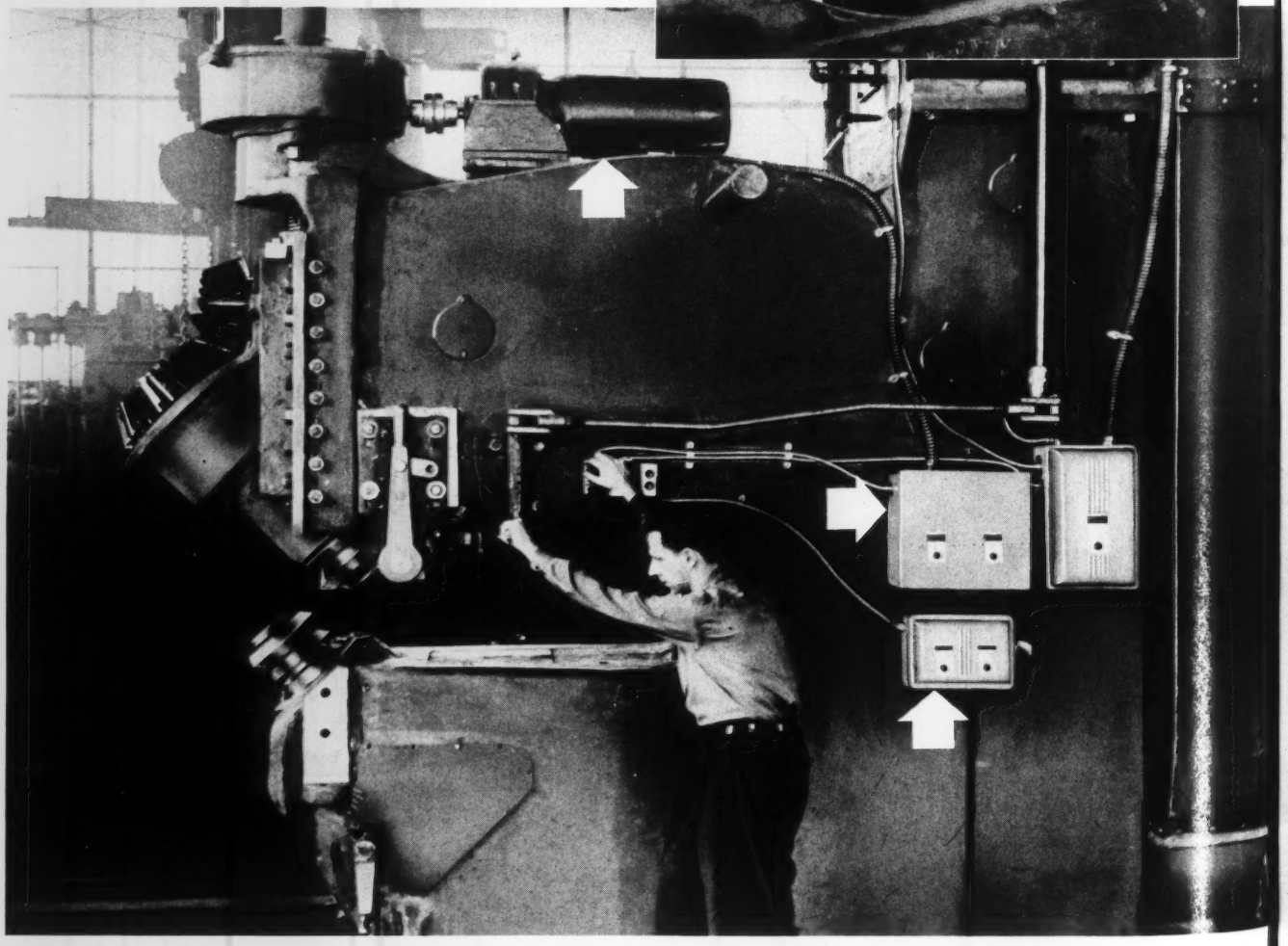
Another major advancement in drive engineering is the Westinghouse Gearmotor. The Life-Line Gearmotor has both motor and gear unit designed as integral equipment. The result? There is a major saving in space because all belts, chains and pulleys can be eliminated. Hence, no alignment problems. This means faster mounting onto or into equipment and into tight quarters.

Horizontal split case construction permits the gear cover to be removed in minutes, and makes all working parts readily accessible, without removing gearmotor from driven load; Life-Line can be inspected in one-quarter the time required for conventional designs.

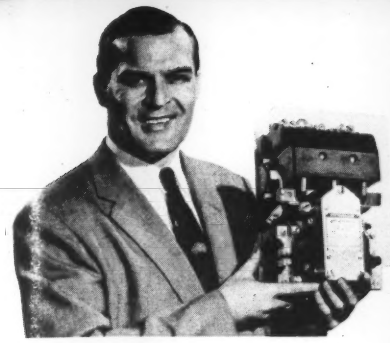
Westinghouse also designs and builds a complete line of speed reducers and other gearing products, and coordinates them into complete drive systems for the machine designer.

The illustration below is a Westinghouse Life-Line Gearmotor with motor brake installed on top of a rotary shear.





YOU CAN BE SURE...IF IT'S



Straight-through wiring lets you install a Westinghouse Control Device faster and easier

Here are many design and production opportunities that will save you, literally, hundreds of hours in tool assembly and panel mounting jobs.

1. Life-Line a-c Starter's straight-through wiring—line terminals at the top, load terminals at the bottom—is plainly marked, front accessible. This eliminates hunting for missing terminals, saves time, especially where dozens of starters are being put in place.
2. Pressure-type connectors end looping of wires, and provide quickly made, low-resistance connections for either solid or stranded wire.
3. All parts of the Life-Line are front mounted. Construction is simple and compact to provide quick mounting and plenty of wiring room.
4. In NEMA sizes 0-5, Life-Line Starters are of best design—one design for installers to learn and to work with. Interchangeability of components economizes on stocking of parts.

Add-a-part panel

One of many important new developments in Westinghouse Control is the reduced voltage starter which minimizes shock of motor starting torque on the driven machine and reduces starting current in-rush, limiting voltage dips on the power line. The standard starter panel is drilled so that additional relays, voltage and current transformers may be added in the field without change of enclosure size.

Manufacturing facilities are available in many Manufacturing and Repair Plants to build panels locally and quickly.

Westinghouse

You save space, simplify wiring because

Type AM time delay relay

The adjustable timing pneumatic device shown above combines a relay and timer in one compact unit that saves panel space, and can be supplied in various circuit combinations.

New AB Circuit Breakers

Three recent developments in Westinghouse Circuit Breakers ease the squeeze on space, especially in panels that must hold many devices.

The new E Breaker, formerly rated 50 amps, has been redesigned for 100 amps with no increase in size.

The new J Breaker is only 10⅛″ high compared with 15½″ for conventional 225-amp breakers. Saves at least 34% mounting space in panels, switchboards, control cabinets and other enclosures.

The new, Visible Blade Load Break De-ion® Switch is a fusible or non-fusible disconnect for all types of control panels up to 150 hp, 600 volts, a-c. It's the smallest, Visible Blade Load Break Switch available.

Space saving means smaller cabinets, more wiring room, faster line assembly.

AB CIRCUIT BREAKERS—In the widest selection of frames, Westinghouse Breakers provide not only reliable circuit protection for the life of the installation but more compact sizes, rating for rating, than available anywhere else.

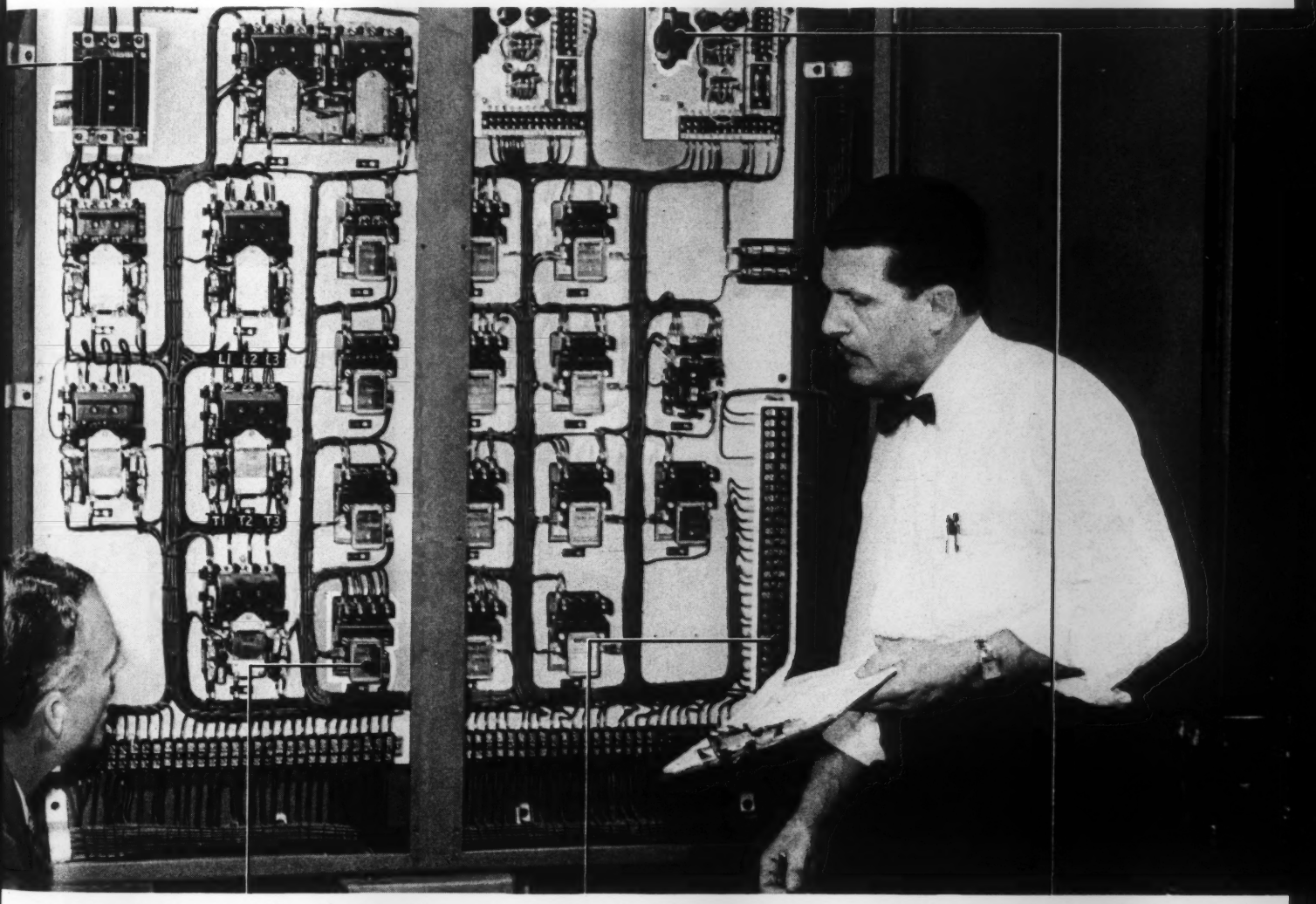
A full line of control components

Compare the full line of Westinghouse Control Devices. Together they make the team you're looking for to slice hours and dollars from assembly costs. They include standard, heavy-duty and Oil-Tite* pushbutton units and control stations; magnetic controls featuring the advanced Life-Line Starter—best in design in NEMA ratings 0-5; manual controls including motor snap switch, Motor Sentinel*, Motor Watchman® and the widely used NEMA 1A manual starter; famous AB De-ion circuit breakers, control components; relays (including the new, highly versatile Type N relay), contactors, timers, transformers, terminal blocks and many other devices for control panels.

Trade-Mark

YOU CAN BE SURE...IF IT'S **Westinghouse**

Westinghouse components are compact



TYPE N CONTROL RELAY—Here is a versatile unit designed on the same principles of compact structure as the Life-Line Starter. Many pole combinations in the same basic relay, easy contact convertibility from normally open to normally closed, and quick coil change provide many laborsaving design opportunities.

UNIT TERMINAL BLOCKS—Mounting channels in 48″ lengths, easily cut to any size. Individual blocks can be readily added or changed without disconnecting adjacent wiring; contributes to easier panel planning, quicker wiring and mounting.

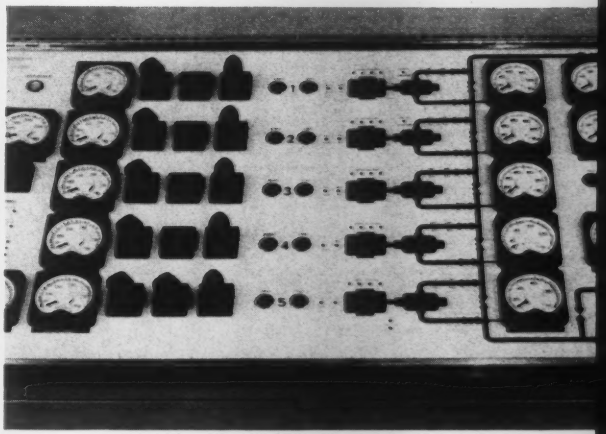
CONTROL CIRCUIT TRANSFORMERS—This compact unit, with superior voltage regulation characteristics, assures positive control action at normal line voltages found in plants. It can be installed in either individual enclosure or control cabinet.

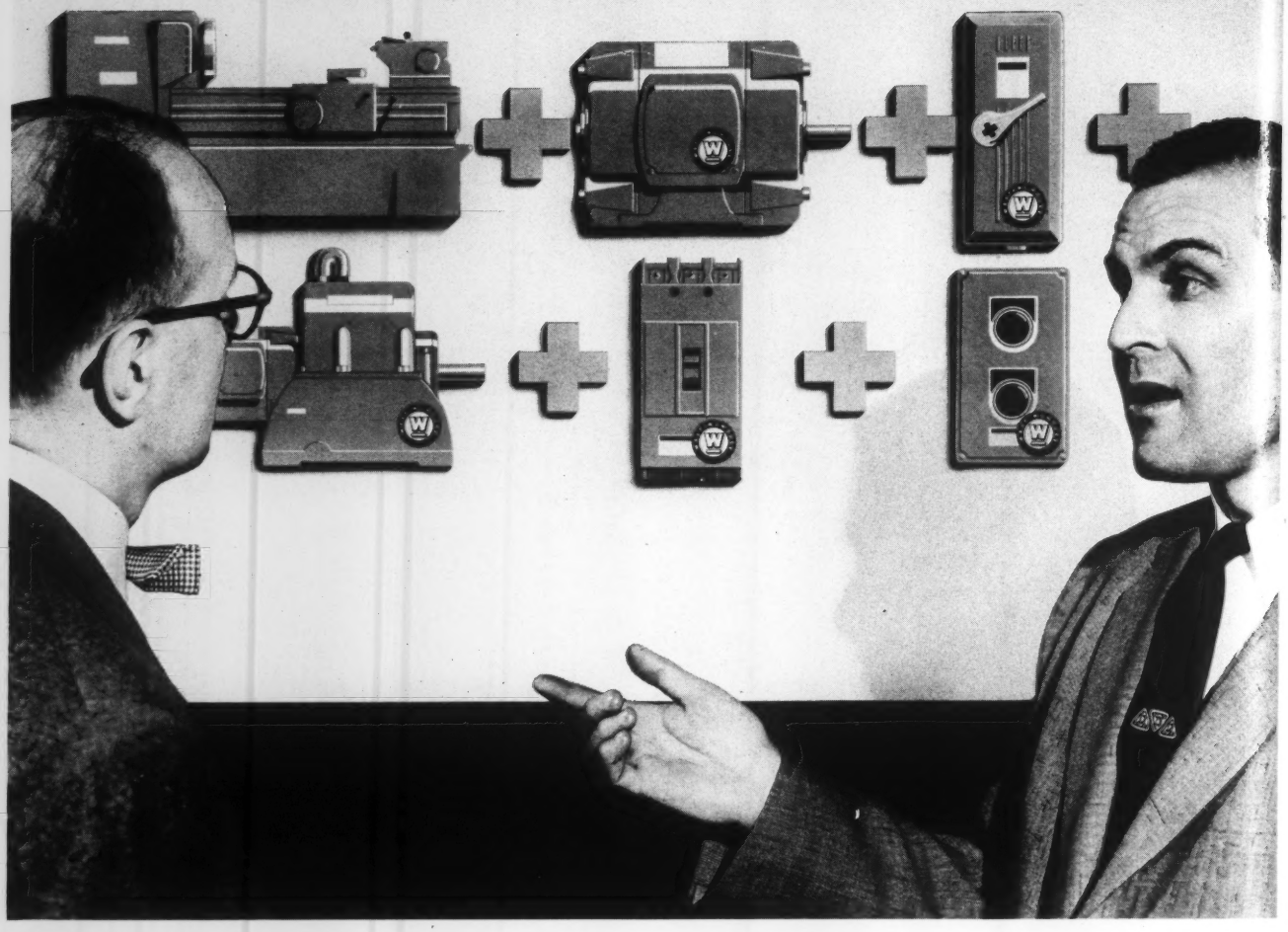
More readable instrument dials save panel space

Westinghouse K-24 Full-View, Circular-Scale Instruments can be read accurately from more than 20 feet or from a 65-degree angle. Super readability like this means that K-24 instruments need not be kept at eye level. They can be mounted anywhere on the panel and still be read easily. A special case design and the use of proved optical principles in dial and cover combine virtually to eliminate shadows and glare, even under adverse lighting conditions.

Circular scales of K-24 instruments provide a pointer travel twice that of other types which require the same panel space.

These features show why the use of K-24 instruments will result in smaller, more compact designs, whether in cabinets, on consoles or other equipment.





Together these components help you design to beat competition

In modern equipment, electrical drives and their many attendant control components throw a real challenge at designers and production planners. Westinghouse has one important answer for you: a team of products that not only electrify, coordinate, protect or automate productive processes . . . but products that help the builder hammer down production line operations, standardize wiring procedures, save mounting space, reduce over-all assembly costs . . . products that help you design for competition.

Individually, Westinghouse products provide proved, cost-saving features. Together, they will give you an unbeatable combination.

Many of these same design advantages of Westinghouse drive equipment also provide your customers with timesaving, maintenance-free, long-lived performance that spells repeat sales for you. Westinghouse quality works hand in hand with the basic skills you build into your equipment.

Nationwide network of maintenance facilities

38 large and well-equipped Westinghouse Apparatus Repair Shops are available to your customers for maintenance jobs on every conceivable type of electrical apparatus. Supplementing these are many authorized motor service stations in other strategic locations.

46 Field Service Offices are ready to make inspections, adjustments and on-the-spot repairs for equipment that cannot be moved easily.

Fast delivery of Genuine Westinghouse Renewal Parts from stock in 31 locations enables you to keep low parts inventories at your plant.

Call your Westinghouse Representative for any of these or other services.

MP-5307

WRITE WESTINGHOUSE FOR ANY OF THE FOLLOWING LITERATURE

Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

New Life-Line "A" Motor B-6154 • *Life-Line AV Drives* B-5808 • *Life-Line Gearmotors* B-5645 • *Automatic Operations Start with Westinghouse Control* B-5882 • *Complete Industrial Control and Services* B-6051 • "Controls De-mystified" Film • *K-24 Instruments,* Catalog 43-200 • *Preventive Maintenance* B-5477A • *Speed Reducers* B-5646

YOU CAN BE SURE...IF IT'S Westinghouse

Litho in U.S.

DU PONT
REG. U. S. PAT. OFF.

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

REG NEWS

NO. 3 — 1954

Packing of Du Pont "Teflon" Functions after Two Years' Service in Fuming Sulfuric Acid Pump

Lightweight "Zytel" nylon useful in components of aircraft wiring systems

THE properties of Du Pont "Zytel" nylon make this versatile engineering material particularly adaptable for electrical

Sixteen miles of cable jacketed with "Zytel" are used in one airplane. The thin, abrasion-resistant nylon jacket assures a durable insulation to gasoline, abrasion.

systems. "Zytel" is used for cable clamps, strain-relief clamp blocks, grommets, wire guides and support blocks, terminal blocks, and similar devices.

Du Pont "Zytel" is specified for these applications because it is tough, resists abrasion and extremes of temperature, and has the necessary dielectric characteristics. It can be molded into intricate shapes . . . is strong in thin sections.

These same properties of "Zytel" are utilized in cable jacketing. One type of airplane carries sixteen miles of cable jacketed with "Zytel." Another property is also important in aircraft—resistance to attack by petroleum products.

Du Pont "Zytel" nylon is used continuously at temperatures normally found in commercial electrical equipment (to about a maximum of 250°F).

Many manufacturing economies are obtained with "Zytel." Injection-molding technique allows rapid molding of complicated shapes. Often a single part molded of "Zytel" nylon replaces an assembly. And, because "Zytel" can be molded around metal inserts, further design simplification is often possible.

"Zytel" is the new trade-mark for Du Pont nylon resin.

Chemically inert, "Teflon" performs equally well as packing, gasket, impeller

DU PONT "Teflon" tetrafluoroethylene resin has proved its versatility many times in applications where conditions were so severe that no other engineering material was adequate.

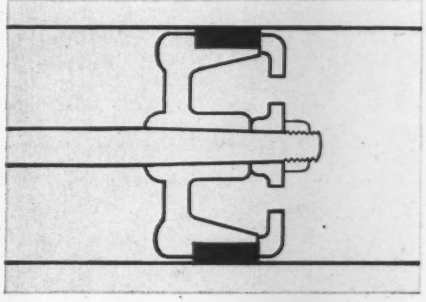
Here are a few examples of outstanding performance by "Teflon":

Application 1. When conventional packing was used in the handling of fuming sulfuric acid, repacking was necessary every two days. Pumps packed with "Teflon" have not needed repacking in two years.

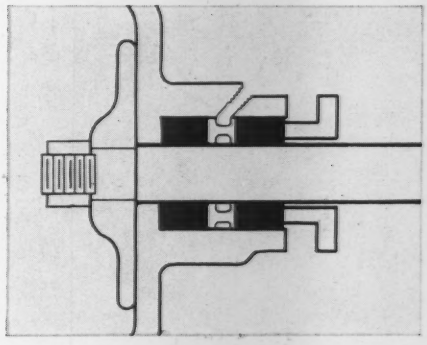
Application 2. One step in the manufacture of pyribenzamine involves thionylchloride in the presence of boiling solvents—a very corrosive mixture. Gaskets of "Teflon" were still in good condition after over a year, while gaskets of other materials deteriorated within a few weeks.

Application 3. Leakage with previous packing in a reciprocating pump handling diacetone was one-half pound per *hour;* leakage with packing of "Teflon" is only one-half pound per *week.*

Application 4. When a pump, worn out from handling silicon tetrachloride at 2000 to 2500 p.s.i., was returned to the manufacturer for servicing, the original packing of "Teflon" was still intact. The former packing required servicing every two or three days.



After many months' service on this horizontal duplex pump, rings of "Teflon" showed no signs of wear.



Packing of "Teflon" on this centrifugal pump gives long life, cuts maintenance costs.

There are many reasons why "Teflon" tetrafluoroethylene resin performs so well in so many ways—as packing, gasket, or impeller.

For one thing, "Teflon" is inert to all chemicals and solvents normally encountered in industry. Only exceptions are molten alkali metals, fluorine gas at high pressures and temperatures.

"Teflon" remains tough at temperatures as low as −450°F. It is capable of continuous service at 500°F. The tendency of "Teflon" to cold-flow is not excessive, and is confined to the first few hours after compressive load is applied.

"Teflon" resists heat, has zero water-absorption by ASTM test D570-42, and is unaffected by outdoor weathering. For impeller use, "Teflon" is self-lubricating, has a low coefficient of friction, will not shrink, swell, or crack.

This unique engineering material may help you to simplify designs, reduce maintenance costs, improve process performance. Clip the coupon on reverse side for more information about Du Pont "Teflon" tetrafluoroethylene resin and its applications.

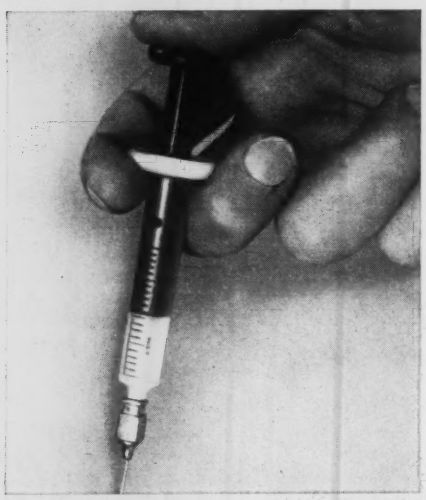
OVER

DU PONT
REG. U. S. PAT. OFF.

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

NEWS

NO. 3 — 1954



Both plunger and barrel of 2cc hypodermic syringe are molded of Du Pont "Zytel" nylon. These parts are tough, unbreakable, and can be sterilized with dry heat, by boiling, or autoclaving. Syringe is manufactured by Nelson Products Company, of Arlington, New Jersey.

Investigate Du Pont engineering materials in your product development programs

ONE OF the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and "Zytel"* nylon resin are helping solve industrial design problems.

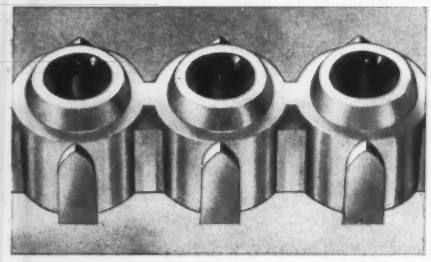
NEED MORE INFORMATION?

CLIP THE COUPON for additional data on the properties and applications of these Du Pont engineering materials.

Battery sealers of Du Pont "Alathon" fit tightly, won't corrode

THE Electric Storage Battery Company, of Philadelphia, Pa., uses positive-plate tube sealers of Du Pont "Alathon" polyethylene resin for the Exide-Ironclad battery. Molded "Alathon" and its versatile properties have effectively lengthened the working life and improved the performance of this industrial battery.

Du Pont "Alathon" is resilient, assuring a tight fit where the sealers cap the plates. Because "Alathon" resists electrolyte and electrolytic action, these battery sealers reduce loss of active material and effectively lengthen battery life. And non-corrosive "Alathon" insulates the plate bottoms, preventing short circuits.

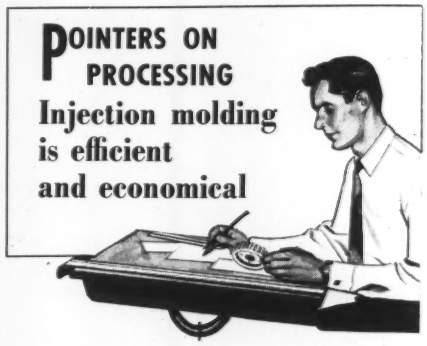


These intricately shaped sealers of Du Pont "Alathon" polyethylene resin are rapidly mass-produced by means of injection molding.

Be sure to evaluate the versatile combination of electrical, mechanical, and chemical properties of Du Pont "Alathon" polyethylene resin. These properties may help solve your own design problems. For more information, clip the coupon below.

POINTERS ON PROCESSING

Injection molding is efficient and economical



INJECTION molding, as a method of mass-producing parts made of Du Pont engineering resin materials, has been developed mainly within the past ten or fifteen years. Improved techniques have accompanied that development.

Injection molding offers the advantages of high production rates, low unit cost, and usually does away with finishing operations. One important saving which has been effected by injection molding occurs when the molded piece replaces an assembly of parts.

High Production Rate. Multi-cavity dies have been made which produce hundreds of identical pieces at a time. Molding time and cycle vary with the size of the part and its shape. The injection-molding process is versatile, and is used to produce a wide variety of quality parts, rapidly and economically.

Low Unit Cost. Another positive value of injection-molded parts is the low cost of fabrication per part. While the initial cost of the mold itself is high, a mass-production operation makes the cost per piece low. Loss of molding material is generally low, too.

No Finishing Operations. With good molding techniques, pieces can be injection-molded to close tolerances. In many cases, molded pieces require no finishing operations. Thus, large savings in time and expense can often be realized.

Simplified Designs. The versatility of injection molding often permits design simplification. Du Pont "Zytel" nylon, for example, can be injection-molded into intricate shapes, as well as around metal inserts. Du Pont "Alathon" polyethylene resin and "Lucite" acrylic resin can also be successfully injection-molded into a variety of useful forms.

E. I. DU PONT DE NEMOURS & CO. (Inc.) POLYCHEMICALS DEPARTMENT
Room 126, Du Pont Building, Wilmington 98, Delaware.

Please send me more information on the Du Pont engineering materials checked: ☐ *"Zytel" nylon;* ☐ *"Alathon";* ☐ *"Teflon";* ☐ *"Lucite." I am interested in evaluating these materials for*_____

NAME_____ POSITION_____

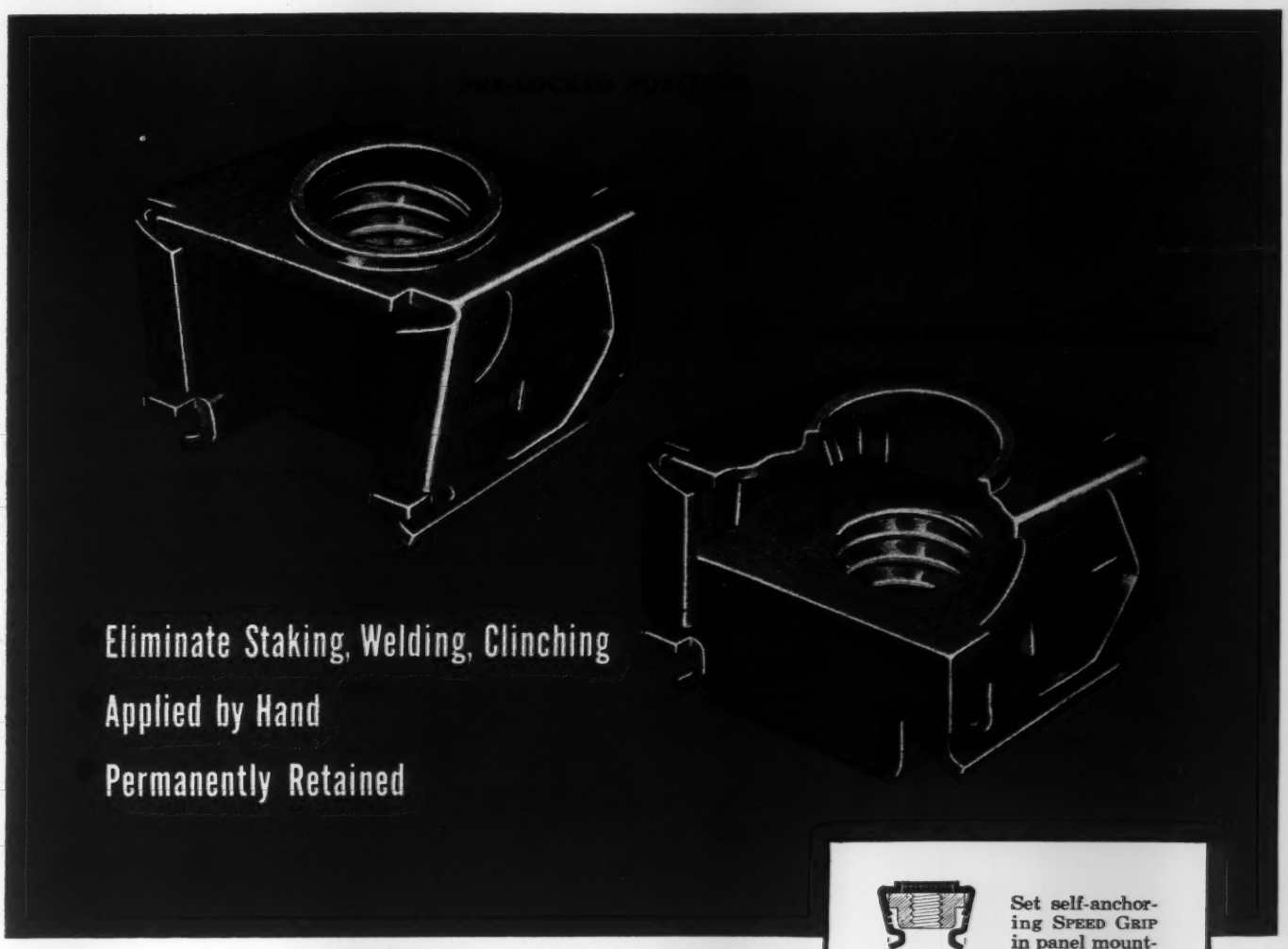
COMPANY_____

STREET_____

CITY_____ STATE_____

TYPE OF BUSINESS_____

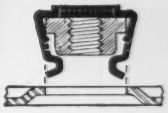
*"Zytel," "Alathon," "Lucite," "Teflon" are trade-marks of E. I. du Pont de Nemours & Co. (Inc.)



New, Self-Anchoring SPEED GRIP®
cuts assembly costs in half!

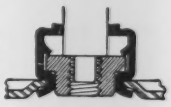
Whatever your present method of attaching square nuts to panels, new self-anchoring SPEED GRIPS can do the job faster, easier, better. This unique fastener has spring steel "mechanical hands" that permanently lock the nut in bolt-receiving position. It cannot be dislodged even with rough handling. Applied after painting or porcelainizing, there is no clogging, retapping or masking of threads to bother about. *And* it is ideal for blind location attachments.

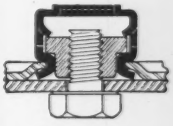
Total up the savings in application time—in expensive assembly equipment—in handling time—in assembly steps—and you'll switch to self-anchoring SPEED GRIPS—the newest addition to the complete Tinnerman line of Nut Retainers.



Set self-anchoring SPEED GRIP in panel mounting hole.

Simple tool presses nut into locked position.





Heavy duty nut in locked position—permanently retained—can't rotate, rattle or be dislodged.

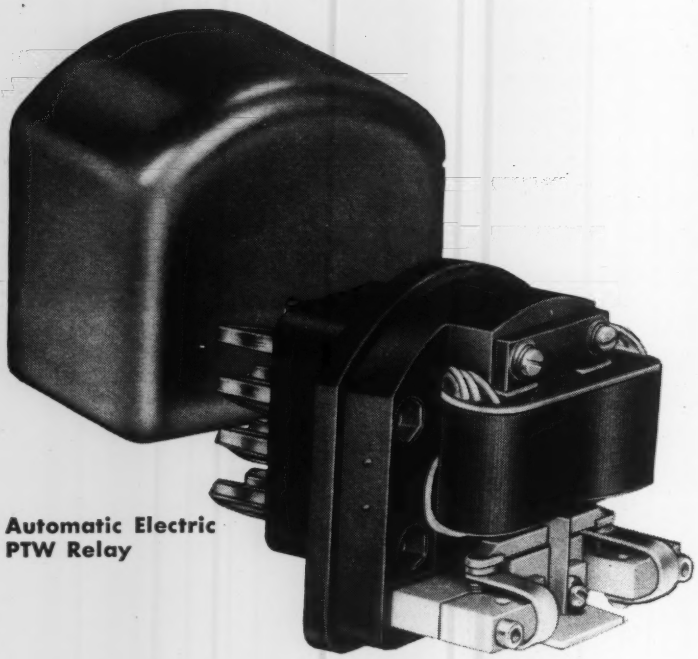
Write today for free copy of new detailed SPEED GRIP Bulletin, No. 335. Tinnerman Products, Inc., Dept. 12, Box 6688, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S.A., 7 rue Henri Barbusse, Levallois (Seine).

TINNERMAN Speed Nuts®

MORE THAN 8000 SHAPES AND SIZES

New polar relay...

sensitive, rugged, compact!



Automatic Electric PTW Relay

Here's a new polar relay that will soon be setting records for long service life! Its sensitivity gives peak performance for high-speed polarized pulse repeating, or for applications where low current is transmitted over long lines. The Series PTW Relay is also recommended for line-current direction indication or as a differential relay in the "Wheatstone Bridge" type of control. Advanced features include:

simplified design and long service life

New design eliminates many parts and adjustments formerly required. Relay gives *billions* of operations without re-adjustment.

extreme sensitivity

Unit operates on currents as low as 2 to 12 milliamperes, depending upon number and combination of windings used. Signals as low as 10 milliwatts through the two line-windings will "trigger" the relay.

reduced bounce and wear

A new method of armature support limits longitudinal movement. There are no bearings to wear . . . the usual rocking motion in contact make-and-break is reduced. Armature bounce is virtually eliminated; contacts last longer.

improved characteristics in smaller size

Because of increased magnetic efficiency, the coils take less space and need fewer turns. The lower coil impedance of this compact unit gives improved characteristics.

fast response

Travel time is as low as .9 milliseconds, depending upon contact gap and windings used.

send for circular

For a small, fast, sensitive polar relay that out-performs and outlasts all others, specify this new Automatic Electric Series PTW Relay. For details ask for Circular 1821. Write: Automatic Electric Sales Corporation, 1033 West Van Buren St., Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto. Offices in principal cities.

helpful technical data

Make and Break—75% total "make" on both contacts at 60 cycles per second with .006" contact gap and 23 milliamperes of sine wave ac. Simple, easy re-adjustment can be made in the field.

Windings—Four windings: two line-windings, each 139 ohms resistance and only .5 henry inductance; other two windings, each 101 ohms and .125 henry. The number of coil turns to be placed in series aiding can vary from 1400 to 8400.

Cover—Snap-on cover easily removed for inspection and adjustment of relay.

Mounting—Jack mountings, available for flush or surface mounting.

Size—2¼" wide, 2½" deep and 2 1/16" high (plus ⅝" projection of banana plugs).

For more detailed information, ask for Circular 1821.

RELAYS SWITCHES

PRODUCTS OF THE INDUSTRIAL DEPARTMENT OF

AUTOMATIC ELECTRIC

CHICAGO

Reynolds
ALUMINUM REPORTER

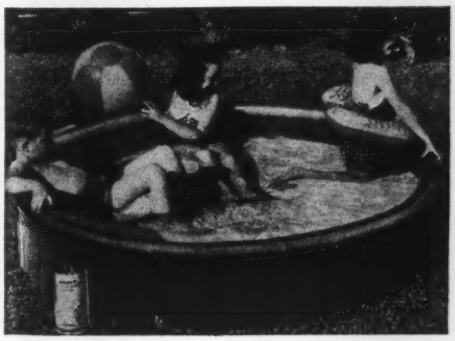
★ ★ ★ Fourteenth in a Series to Industry on Aluminum Uses and Developments ★ ★ ★

NEW ALL-ALUMINUM MOBILE HOME MAKES NEWS

Aluminum and Plastic Team Up to Make New, Improved Wading Pool

This novel wading pool made by the Ideal Toy Corporation, New York 10, N.Y., offers a good example of design and engineering skill in getting maximum benefit from the right combination of materials in a product. Ideal engineers wanted a sturdy pool—yet one easily inflatable and simple to set up. They found the solution through judicious use of both aluminum and plastic.

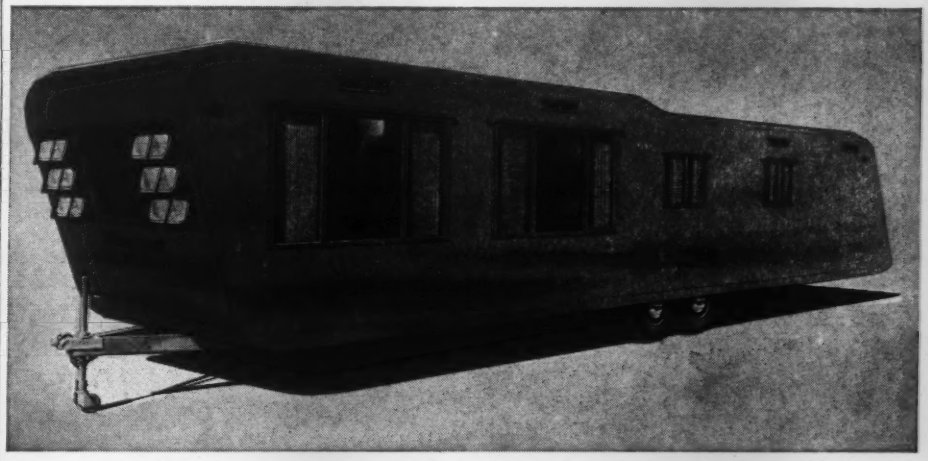
Named the "Aquarama," this wading pool features an all-aluminum wall with safety rolled edges and an inflatable one-ring inner liner made of heavy gauge vinyl. The aluminum wall—made of Reynolds Aluminum—prevents loss of water experienced with unsupported depressed sides and also protects the plastic against rough use. This non-rusting aluminum wall rolls into a compact coil around the deflated pool and comes packed in a convenient shipping carton. Pool with Inflato-Pump and other extras retails for under $20.



This Ideal Wading Pool is sold in sporting goods, furniture, hardware and other stores handling children's play equipment. It also is one of the growing number of quality products that carry the new "Designed in Reynolds Aluminum" Seal. For details on how the aluminum products you fabricate can qualify for this seal merchandising program simply write to the address below.

Reynolds design and engineering service is available to all manufacturers, not only those working exclusively with aluminum but also to those who use it in combination with other materials in their products. To get the most from the aluminum you use—alone or judiciously combined with other materials—call your nearby Reynolds Office, Reynolds Distributor, or write Reynolds Metals Company, 2576 So. Third St., Louisville 1, Ky.

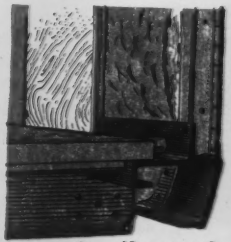
Mon-O-Coach "041" Hailed as Major Design and Engineering Achievement in Mobile Home Development



The revolutionary all-aluminum Mon-O-Coach "041" Mobile Home shown above features new monocoque stratoliner construction in which the entire body of Reynolds Aluminum is one strong unit instead of body-on-frame construction. The drawing below shows how extruded aluminum bottom, sidewall and top members make a one-piece riveted unit reinforced with aluminum castings.

Reynolds engineers were asked in by the builder—the Mon-O-Coach Division of Ironwood Trailer Coaches, Inc., Ironwood, Michigan—right at the initial design stage. These Reynolds engineers worked closely with Mon-O-Coach engineers through completion of the job.

According to the manufacturer, Reynolds Aluminum and monocoque construction make this mobile home up to 4,000 pounds lighter—structurally about one-third lighter than conventional trailers—more mobile . . . easier to pull . . . more economical on the road. All-aluminum construction also eliminates any chance of buckling, warping, corrosion and bi-metallic action.



The assistance of Reynolds engineering and styling service is available without obligation to help manufacturers make full use of aluminum's many advantages. For example, aluminum is light but strong . . . is always attractive (frequently without special finishes) . . . has excellent heat and light reflectivity . . . high electrical and thermal conductivity . . . is low in cost and often permits fabrication economies.

Consult Reynolds Aluminum specialists on your next design or redesign project. Call the Reynolds Office or your nearby Reynolds Distributor listed under "Aluminum," in your classified telephone directory, or write direct.

New Reynolds Rotor Metal Used in Induction Motors

Reynolds development work has proved that a new rotor metal of 99.3% minimum aluminum content with a conductivity of 54 to 57% of the annealed copper standard will produce motors averaging as high or higher torque than higher purity, higher conductivity range material.

This apparent contradiction is the result of close control of the alloying elements. When cast in this metal the rotor bars are less apt to pull apart during solidification and cause loss of electrical contact and ultimate loss of torque. Also, the aluminum has less tendency to weld to the laminations and welding that does occur is broken free more easily by subsequent heating.

Prime advantages of die cast aluminum rotors over copper windings for induction motors are lower material and fabricating costs and lower centrifugal forces exerted on bearings during the motor operation. Write for more complete information.

For more complete aluminum design information send for "Aluminum Structural Design" and "Designing with Aluminum Extrusions." Single copies of these handbooks are free when requested on business letterhead. Write Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

MORE ABOUT ALUMINUM ON NEXT PAGE

(Advertisement)

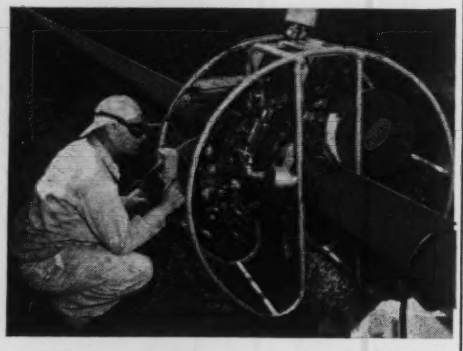
Printed in U.S.A.

(Continued From Preceding Page)

New Automatic Welder Used to Lay Longest Aluminum Pipeline

A new portable automatic welding machine, used during the laying of the longest aluminum pipeline ever installed, welded 40-foot sections of 8⅝-inch aluminum pipe in an average time of four minutes for a five pass weld, compared to about eight minutes or more for welding pipe in place by hand, the method commonly used for steel pipe.

Suspended over the line by a side boom, the automatic welder is equipped with quick-acting clamps which grip the pipe. Pressing a button starts the welding and automatic controls maintain proper conditions of the arc. When the weld is complete, the machine automatically stops, reverses itself, and returns to the starting position. The clamps are released and the machine moves to the next weld.



Welds made during the laying of a 12-mile high-pressure line were subjected to pressure as high as 1800 pounds per square inch, and held firmly. The 40-foot aluminum pipe sections used weigh only 320 pounds while the same size section of steel pipe weighs about 1000 pounds. Reynolds technicians point out that this makes possible savings in handling, equipment and labor which virtually offset the higher cost of aluminum pipe.

The new machine—used in laying the high-pressure pipeline between the White Point gas field near Corpus Christi, Texas and the Reynolds Metals Company LaQuinta alumina plant—was a cooperative development of Reynolds and Air Reduction Sales Company.

Reynolds and Unions Observe "Twenty Years of Harmony"

Production workers in Reynolds Metals Company's Louisville, Kentucky plants recently expressed their appreciation for 20 years of harmonious labor-management relations by presenting a scroll to R. S. Reynolds, Sr., chairman of the Reynolds Metals board of directors and founder of the aluminum firm.

Matt. W. Davis, business agent for Aluminum Workers Local 19388, serving as spokesman for that local and 12 other unions with a total of 2300 workers in the Reynolds Louisville plants, declared: "Our local doesn't have one unanswered grievance. The company very readily sits down and works out any problem it has with a union. It has been about seven years since we had to take a case to arbitration. And we have full employment."

Many Diversified Industries Take Advantage of the Vast Production Facilities Offered by Reynolds Aluminum Fabricating Service

More companies in more industries are taking advantage these days of the facilities offered by Reynolds Aluminum Fabricating Service for producing aluminum parts. Following are some of the reasons why so many companies in both large and small industries are using this service.

New Technical Handbook, "Heat Treating Aluminum Alloys," Now Available From Reynolds

This new 122 page handbook—containing more than 75 photographs, drawings and tables—explains the principles and procedure for heat treating the aluminum alloys.

The book is in three parts. One section presents in easily understood form the metallurgy involved in the heat treatment of aluminum alloys. Another section is of particular interest to the metallurgist and contains data of a more technical nature on both heat-treatable and non-heat-treatable aluminum alloys. A third section presents complete technical processing data in easy-to-follow tabular form.

Single copies of "Heat Treating Aluminum Alloys," are free when requested on your business letterhead (otherwise the book is $1.00). A complete index of Reynolds design, fabrication and application literature is also available. Write to Reynolds Metals Company, 2576 South Third Street, Louisville 1, Kentucky.

Aluminum Irrigation Pipe Helps Fight Ground and Forest Fires in Michigan

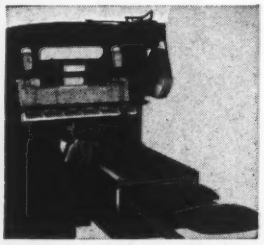
Aluminum irrigation pipe has been used successfully for water transmission to ground fires by the Department of Conservation in the State of Michigan. They started with 1600 feet of 3-inch aluminum pipe and quick acting aluminum couplers supplied by the W. R. Ames Company, irrigation equipment manufacturers, of San Francisco. When this proved highly successful, additional footage was ordered.

In one ground fire where both aluminum pipe and hose were used, the 1600 feet of 3-inch pipe was loaded on a trailer by four men in just thirty minutes while it took five men two hours and twenty minutes to load 2000 feet of 2½" hose. In addition, four men were kept busy for an entire eight hour day to uncouple, dry, clean and roll the hose—another case where aluminum irrigation pipe saved time and labor.

First, there are over 200 pieces of major production equipment in two plants alone operated by Reynolds Aluminum Fabricating Service. This equipment includes presses from the very smallest up to presses capable of producing drawn parts 12′ long. Also included are roll forming machines, some of the most modern aluminum welding equipment in the country and some of the most up-to-date automatic anodizing equipment.

Second, Reynolds Aluminum Fabricating Service, because it has produced aluminum parts for diversified industries for many years, has the necessary fabricating experience. Through this experience has been gained a practically unparalleled knowledge of the fabricating of aluminum parts requiring blanking, embossing, stamping, drawing, riveting, forming, roll shaping, tube and shape bending, welding, brazing and finishing.

Third, Reynolds Aluminum Fabricating Service offers important savings to parts customers in many ways. Most important, parts customers do not tie up their capital in raw material inventory and they do not have to buy "specialized" equipment which might be in use only part of the time. Parts from Reynolds are shipped ready to assemble into final products. This also saves on production losses, rejects and scrap handling and storage.



And fourth, Reynolds Aluminum Fabricating Service offers the services of trained engineers who will help in your design problems. To get this design and engineering assistance, simply call your nearby Reynolds Office or write to Reynolds Aluminum Fabricating Service at the address below.

A free 24-page "Catalog of Facilities" is available by writing Reynolds Aluminum Fabricating Service, 2065 South Ninth Street, Louisville 1, Kentucky. Other catalogs covering Appliance Parts and Roll Formed Shapes are also free on request.

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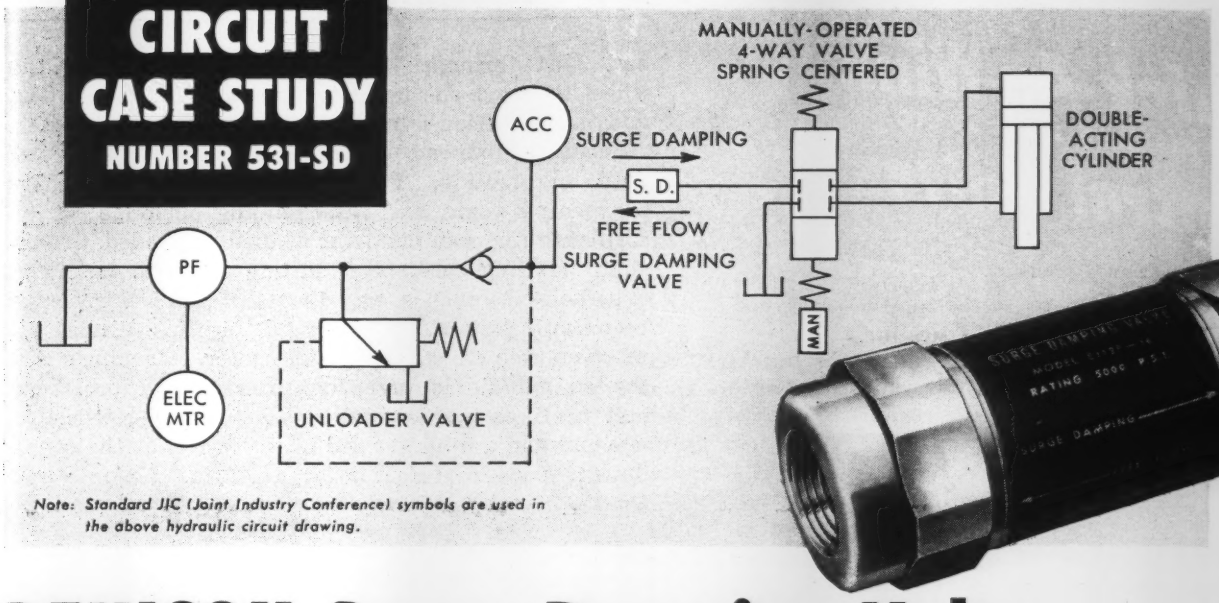
CIRCUIT CASE STUDY NUMBER 531-SD



Note: Standard JIC (Joint Industry Conference) symbols are used in the above hydraulic circuit drawing.

½ ACTUAL SIZE

DENISON Surge-Damping Valve

prevents destructive, noisy *shock* in hydraulic systems

Fast operating at pressures up to 5000 psi without loss of cycle time

The circuit above shows a typical way to provide for intermittent ram action.

A relatively small pump is used, as reserve pressure is stored in the accumulator between applications of ram effort. When pressure in the accumulator reaches a preset maximum, the unloader valve diverts pump volume to the reservoir at negligible pressure.

Shifting the control of the four-way valve causes the ram to descend on the work, instantly utilizing reserve pressure from the accumulator. Ordinarily, this sudden extra volume and pressure produces hydraulic shock, which causes excessive noise and is apt to damage piping joints and seals.

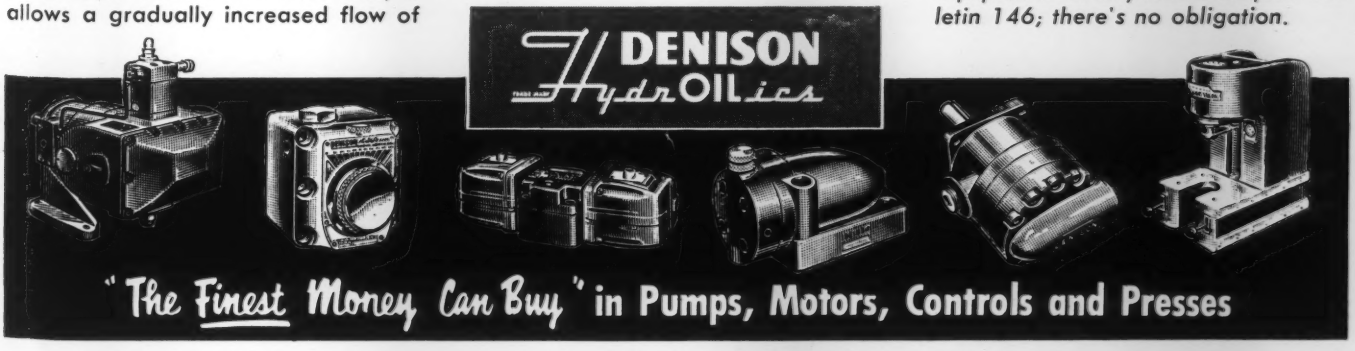
The Denison **Surge Damping Valve** *prevents,* rather than absorbs, this hydraulic shock. It is a normally closed valve, but when line pressure is directed toward the inlet side, it allows a gradually increased flow of oil until fully opened. Then virtually free flow is maintained until oil flow is interrupted—no matter how briefly. The valve then resets instantly, ready for the next ram action.

Operation is simple and positive. The valve body houses a close-fitting spool which must move against and displace a cushion of oil to permit flow through the valve. As the surge of pressure strikes the spool, oil in the cushion escapes through a small orifice. Oil rushing out of this orifice is directed against a normally open flow control device. This flow control is hydraulically unbalanced; therefore, it tends to close under this pressure—the higher the surge pressure, the greater the throttling effect. In other words, speed of valve opening is inversely related to surge pressure increase.

Even under heaviest shock pressures, the valve takes only a split-second to act. In fact, tests prove it takes no longer to act than the duration of an uncontrolled shock impulse.

Denison **Surge Damping Valves** are made in both industrial and aircraft types, for pressures to 5000 psi. They require no adjustments of any kind, need no maintenance, have no moving seals, adjust automatically to any working pressure in any type of circuit, and do not interfere with other circuit functions. An integral check device provides free reverse flow.

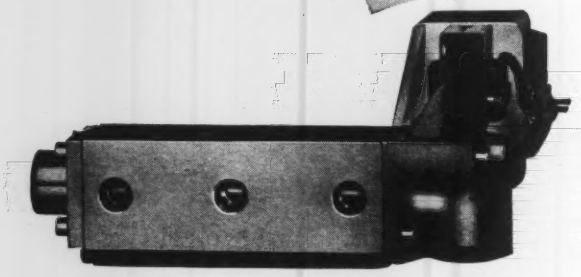
The highly compact and efficient ***Surge Damping Valve*** *(the largest is shown above, one-half actual size) is typical of the complete line of Denison's oil-hydraulic components for circuit pressures to 5000 psi. Wherever the advantages of oil hydraulic equipment can be applied, you can be sure of best results, longest service, and less maintenance when you insist on Denison HydrOILic Equipment. Let us give you full information on hydraulic equipment for any need. Request Bulletin 146; there's no obligation.*



The DENISON Engineering Company, 1156 Dublin Road, Columbus 16, Ohio

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

FEATURE THIS MONTH



Single Plunger Solenoid Pilot Operated Valves

They'll give you millions of cycles of efficient trouble-free operation

● Quick-As-Wink Solenoid Valves are unsurpassed for positive, trouble-free dependable service . . . they give users millions of cycles of fast, high speed — and safe — operation. All parts are rugged. Low amperage requirement of the solenoid eliminates intermediate relays and simplifies electrical circuits. ⅜" to 2" sizes. 2-way, 3-way or 4-way actions. Bucking cylinder or double solenoid return. Send for the data sheets. Get full details about Quick-As-Wink, America's outstanding valve line, today.

also the following

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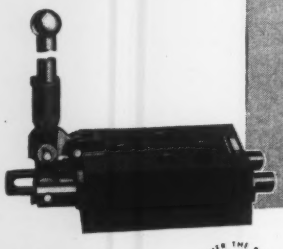
Push-pull or push and spring return operation — ⅛" and ¼" tapped connections. Widely used for controlling cylinders and many other applications. Air to 125 psi — vacuum—can also be used in low pressure hydraulic service.

LEVER OPERATED HYDRAULIC VALVES

Two position or three position valves ½" to 1½" sizes for line pressures 1000 to 5000 psi. Can be furnished in neutral, compound-exhaust or compound-on actions. Pilot cylinder operated types available up to 4".



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New Machines

and 3/64 through ⅜-in. Drill is rocked into the wheel to grind one notch, returned, indexed 180 deg, and the operation is repeated for the other notch. An adjustable diamond truing device trues the wheel with one motion. Tilting fixture adjusts for any sharpening angle, and flute guiding bushings can be furnished for each diameter of drill as needed. Crankshaft pointing consists of cutting away, or notching, drill point in such a way that the usual chisel edge becomes a pair of secondary cutting lips, leaving almost no web thickness at the center. Machine's motorized spindle is precision ground with preloaded ball bearings and mounts a 6-in. grinding wheel at one end and a 6-in. general utility wheel at the other. Bench space required is 19 x 12 in. *Union Twist Drill Co., Athol, Mass.*

Testing and Inspection

Volt-Ohm-Microammeter: Model 269 has a sensitivity of 100,000 ohms per volt. Two controls are provided—one for setting range desired, the other for ohm adjustment. Measurement accuracy is 3 per cent dc and 5 per cent ac of full scale deflection. Instrument has 33 ranges. It measures 6 x $2\frac{15}{16}$ x $7\frac{15}{16}$-in. and weighs 4 lb. *Simpson Electric Co., Chicago, Ill.*

Electronic Metal Detector: Sensitive to all metals, ferrous or nonferrous, instrument is available with a wide range of signal and reject system arrangements to provide automatic detection, with manual, semi-automatic or fully automatic rejection of tramp metal. Detector consists essentially of a search coil unit embodying a transmitting and receiving coil which is mounted around the belt of the conveyor, nonmetallic pipe or chute; and controls. A piece of metal entering the search coil aperture disturbs the balanced circuit between the two coils and detection is made. *Dings Electronics Inc., Milwaukee, Wis.*

Internal Thread Comparator: Precision instrument is designed for visual gaging of all forms and classes of internal threads, in diameters ranging from ⅜ to 1½ in. Threaded parts can be gaged at the rate of 20 or more pieces per minute. Easily read visual indicator design permits classification of tapped holes within very close limits. All classes of fit, American Standard or Unified Threads, can be checked by means of an adjustment of the indicator tolerance hands. *Hanson-Whitney Co., Hartford, Conn.*

Humidity-Temperature Test Cabinet: Vertical type Weather-Lab is available in standard 20 and 30 ft sizes for simulation of most conditions between 35 and 200 F and between 20 and 95 per cent humidity. Unit is suitable for testing products for conformance to above-freezing JAN, MIL and other government environmental specifications. Access to test space is through two front-opening doors. All cooling, heating, humidifying, dehumidifying and air moving equipment is located within an enclosed portion of the test space. Hermetically sealed refrigeration condensing unit is located within an enclosed machine compartment beneath the test chamber. *Hudson Bay Div., Refrigeration Systems Inc., Chicago, Ill.*

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The CAMERON closed die extrusion forging process opens the door to a great many design features which heretofore had been limited to castings. The improved quality and the lower manufacturing cost which result from machining a CAMERON forging makes it highly desirable to investigate the possibility of your product being forged at CAMERON.

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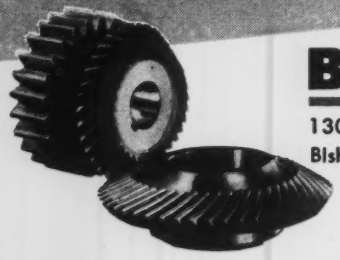

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Valve Manufacturer ELIMINATES

with Electrolizing

The Problem: A fuel control assembly was failing after 400 hours of engine time because of excessive leakage in the diaphragm operated fuel valve. The failure was caused by galling and scoring on the guide lands of the valve.

Combinations of similar and dissimilar metals were tested in an effort to meet the 2000-hour engine time specification. All of them galled within 400 hours. Various surface treatments were tried with negative results.

How it was solved: Following a meeting with the engineers responsible for the project, Electrolized valves were tested with these results:

Shake table vibration test

1. Electrolized valves showed no signs of galling or scoring.
2. There was no measurable leakage.

2000-hour engine test

1. Electrolized valves showed no signs of galling or scoring.
2. There was no measurable leakage.

Following repetitive tests, the unit was accepted. ELECTROLIZING is now a print specification.

What it can mean to you: If you are searching for an answer to galling, friction, wear, abrasion, or corrosion problems, ELECTROLIZING is the ideal starting point. At no cost and without sacrificing project time, you can quickly appraise this process in terms of your own needs. Our 16-page booklet will help you. It describes some of the difficult engineering problems that have been solved with ELECTROLIZING.

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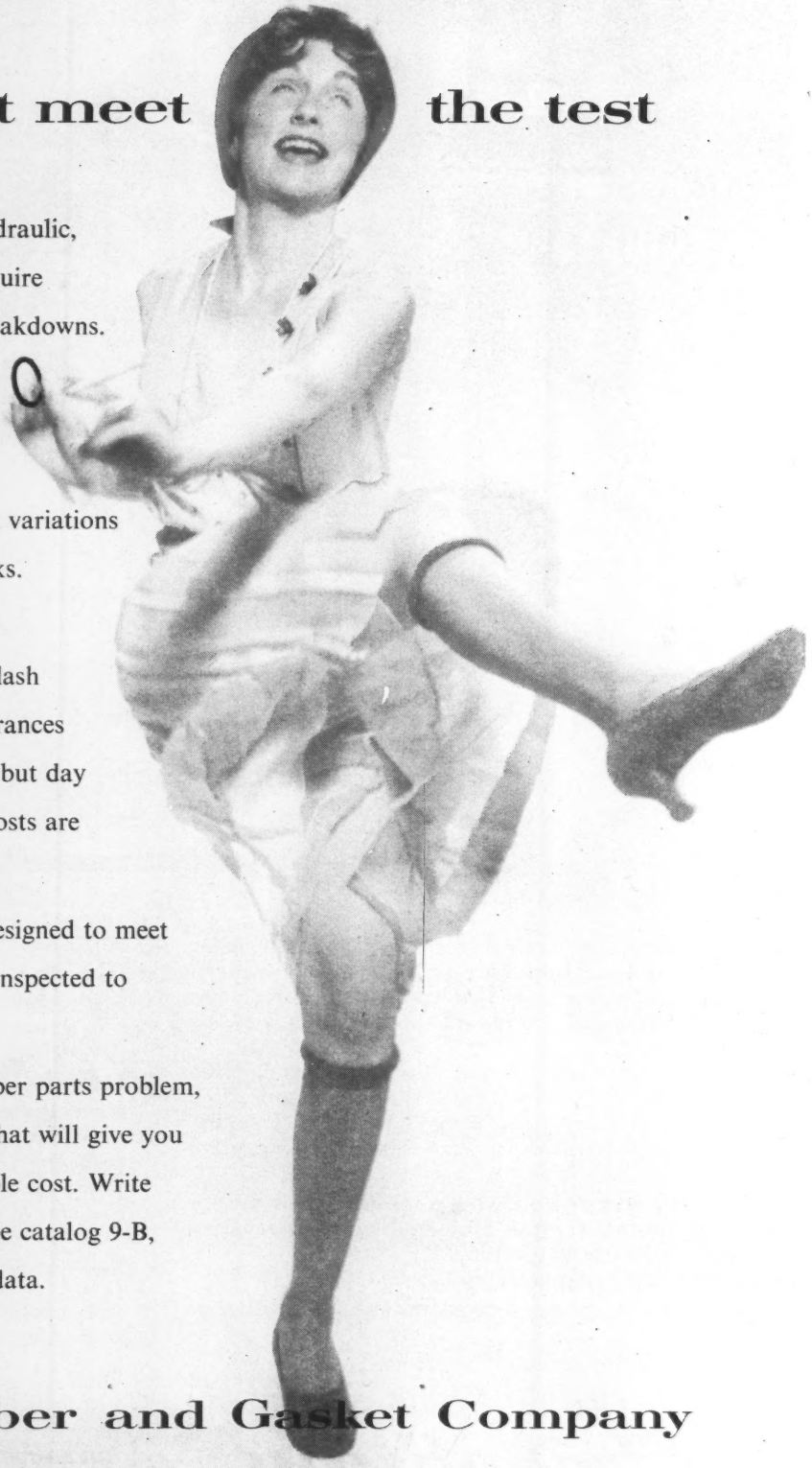
O-rings that meet the test



More and more of today's costly hydraulic, electrical and mechanical devices require precision rubber seals to prevent breakdowns. But requirements are becoming so tough, *ordinary*, *compression molded* O-rings can't do the job—trimming blemishes create ring fractures, slight variations in cross-sections cause damaging leaks.

Minnesota Rubber's exclusive *rubber injection molding* process eliminates flash and trimming problems. Result: tolerances within ±.001 inch—not occasionally, but day after day! Density is much higher. Costs are lower than the industry average!

All Minnesota Rubber O-rings are designed to meet all industry standards. Every part is inspected to maintain consistently high quality.

No matter how old or new your rubber parts problem, Minnesota Rubber knows the steps that will give you the best answer—at the lowest possible cost. Write today for details. Ask for the new free catalog 9-B, "O-rings," for complete installation data.

Minnesota Rubber and Gasket Company

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Dept. 306, Phone MOhawk 9-6781

"ALL MOTORS ARE NOT ALIKE!"

FOR RUGGED SERVICE, Reliance Motors are built better to last longer. These *Precision-Built* Motors combine maximum strength with shock-resistant frame and bearing-bracket construction. Write for new Bulletin B-2102.

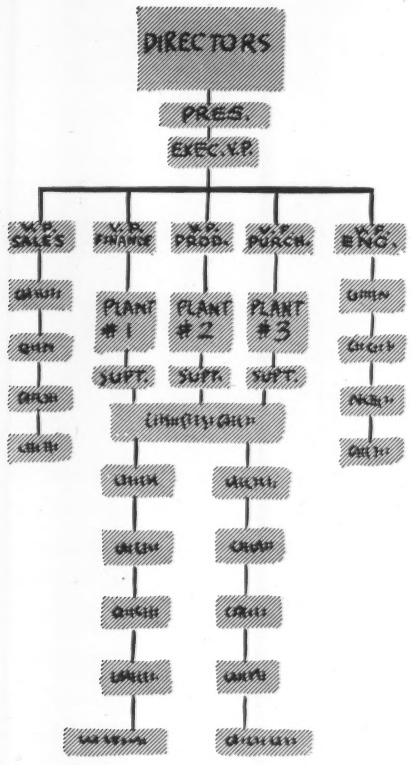
RELIANCE *Precision-Built* MOTORS

B-1470-C

RELIANCE ELECTRIC AND ENGINEERING CO.

1079 Ivanhoe Road, Cleveland 10, Ohio • *Sales Representatives in Principal Cities*

How much SALES POWER does it take today?



Selling to industries isn't what it used to be.

For every worthwhile plant a dozen years ago, you now have two, three, or four to be contacted. Inside the plants, the picture has changed, too. Growth has greatly expanded the number of men who have something to say about the selection or rejection of your products.

You may say, "Oh, we've doubled our sales force to take care of this!" But even a doubled sales force may not be a match for the size and complexity of today's industrial selling job.

Add to this the tougher competition you're up against and you can see why it takes a whale of a lot more SALES POWER now.

It isn't *number* of salesmen alone that determines your SALES POWER. It's the calibre of men—their training —their enthusiasm for your products—and how well their contact time is matched to the real sales potential.

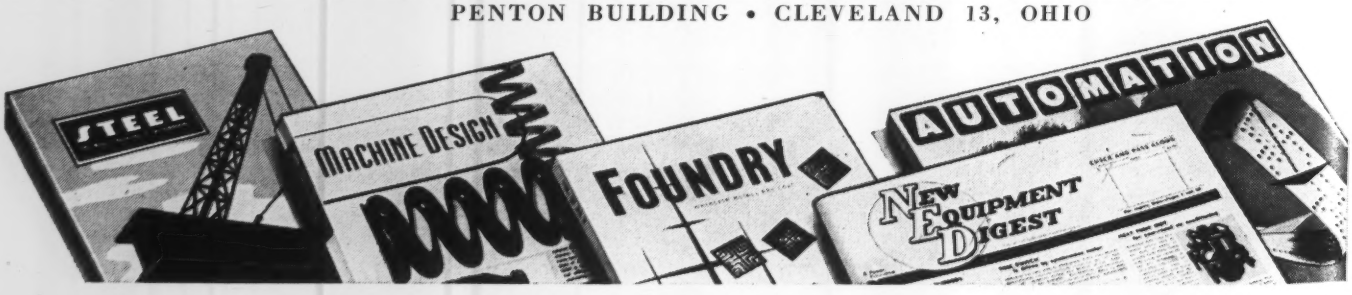
With all these things at their best, your sales force can personally contact only a fraction of the vast parade of buying influences constantly moving through industry's key positions.

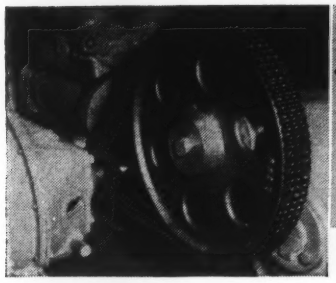
It's the advertising support you give your salesmen that multiplies their effectiveness by making your products wanted in more plants. It's this advertising support that pipes information about your products to far more key men than your salesmen can ever contact personally.

It's this advertising support, adequately related to the size of your selling job, that steps up your SALES POWER and increases the productivity of your sales force. Whether your advertising program is adequate to today's selling job, is something your advertising agency can best help you evaluate.

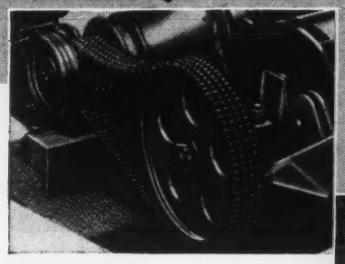
THE PENTON PUBLISHING COMPANY

PENTON BUILDING • CLEVELAND 13, OHIO

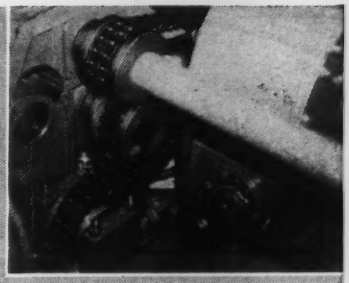




TO TRANSFER POWER
Smoothly and efficiently from motor or engine power source on a primary drive



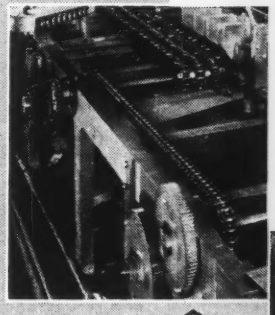
AS SECONDARY DRIVES
(a) Shaft to Shaft



INTRA-MACHINE
(b) Shaft to Several Shafts

TO LIFT
On materials handling, construction and similar equipment

How can you employ DIAMOND ROLLER CHAINS?



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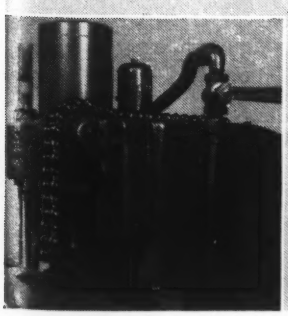
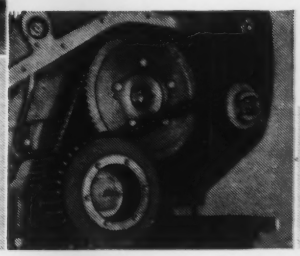
DIAMOND **ROLLER CHAINS**



AS COUNTERWEIGHT SUPPORT



AS TIMING MECHANISM

AEROQUIP HOSE LINES with Detachable, Reusable Fittings

Solve Design Problems

Extreme heat, cold, vibration, installation complexities, and other fluid line problems can be solved readily by the application of Aeroquip flexible hose lines. A variety of hose line types in a wide range of sizes and burst pressures meet every industrial need.

Aeroquip hose assemblies can be made right in your plant, *in minutes*, by cutting bulk hose to length and attaching the reusable fittings. An inventory of bulk stock permits the making of individual hose lines for mock up installations or thousands of hose lines for production runs.

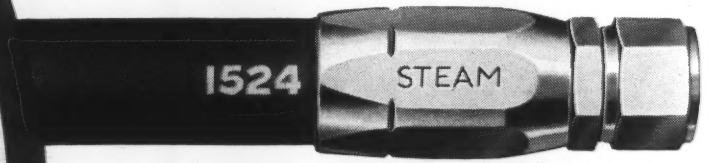
Write for complete hose line information. If you want help on a specific problem, a qualified Aeroquip sales engineer will arrange a call.

Aeroquip double wire braid hose for high pressure hydraulic, hot oil, grease, crude and fuel oil, gasoline, and air lines. Pressures range from 5000 p.s.i. in ¼" size to 1000 p.s.i. in 2" size.

Aeroquip 1500 p.s.i. single wire braid hose for medium pressure hydraulic, water, hot oil, crude and fuel oil, anti-freeze solution, gasoline, diesel fuel, and air lines. ¼" to ¾".

Aeroquip 250 p.s.i. triple-ply cotton-reinforced hose with one-piece SOCKETLESS fittings for low pressure hydraulic, water, hot oil, crude and fuel oil, anti-freeze solution, gasoline, diesel fuel, vacuum and air lines. ¼", ⅜", ½", ⅝"

Aeroquip wire-braid-reinforced butane-propane hose for LPG engine plumbing or for fixed installations where vibration causes problems. This is the only butane-propane hose line listed by the underwriters' laboratories. ¼" to 2".



Aeroquip burstproof hose with *"little gem"* fittings for steam cleaning units, dry cleaning and pressing equipment, foundry equipment, plastic molding presses, steam boiler installations, rubber curing and vulcanizing equipment. ½" to 1".

Aeroquip Freon hose for use on automotive and commercial air conditioning units and refrigeration equipment using Freon 12. Sizes are ¼" to 2".

"Little Gem" is an Aeroquip Trademark

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Compression and Tension Type

Aircraft cable is strung with spherical steel shells in a rigid or flexible housing sealed with "O" rings. 3" standard bend radius. ¾" minimum bend radius.

Three Types:

1. Light Duty—Compression Ult. Load 1250 lbs.; Ult. tension 960 lbs.
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Modernize your push-pull control system with Southwest Mechanical Push-Pull Controls. Eliminate bell cranks, pulleys and dual cables. Send for ENGINEER.NG MANUAL giving detailed prints and complete specifications covering materials, finishes, capacities. Please address Dept. MD-54.

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Shipping Wt.—185 lbs.

SPECIAL PRICE **95.00** F.O.B. Chicago

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CYLINDER

ALSO ITEM #1715

- 7¼" Bore—15¼" Stroke
- 41,300 lbs. Pressure with 1,000 P.S.I. Pump Output
- Other Features Same as Above

Replacement cost $260.00

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ITEM #126—Four-way open center control valve, with built-in adjustable relief valve factory set at 1000 P.S.I. Spring loaded neutral position. For use with one double acting cylinder. In neutral position cylinder is locked and pump unloaded. Can be used as single unit or mounted in series. Has ¾" pipe thread inlet and outlet. ½" pipe thread cylinder ports. Newly manufactured to our specifications. Ship. Wt. 8¼ lbs.

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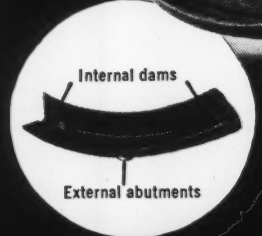
LINEAR VEE-DAM* RINGS



Foolproof to assemble . . . leakproof in operation

Moulded-in rubber dams seal off labyrinth and lateral flow, even when gaps occur in the ring joint through faulty installation. Precision moulded of fabric-reinforced synthetic rubber. Write for details.

*Patent Pending

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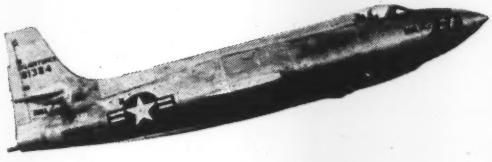
THE BELL X-1A



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Flying at more than 1,600 m. p. h.—twice the speed of a bullet fired from a 22 caliber rifle—the supersonic Bell X-1A is now the world's fastest airplane.

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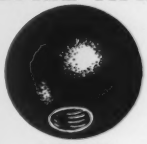

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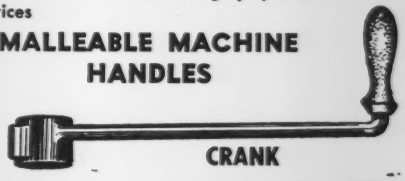
ROUND STEEL

Give product that "dressed up" appearance. Made in a wide variety of diameters and thread sizes. Steel ball handles are turned from bar stock and highly polished. Finest quality at low prices

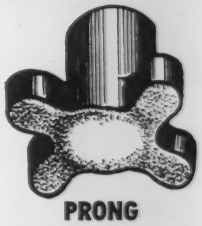
MALLEABLE MACHINE HANDLES



Crank, straight and offset types in wide variety of sizes. Smooth finish. Low prices.

CAST IRON HAND KNOBS

LONG SHANK



PRONG

Three types: Long shank with wrench hex., Scalloped and Prong. Many sizes. Made of fine grain cast iron. Smooth finish. No sharp edges. Low prices

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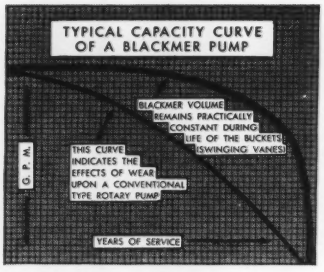

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2. The Blackmer design also features replaceable cylinder liners enabling pumps operating under severe conditions or corrosion and abrasives to be renewed at minimum cost.
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4. The Blackmer pressure control valve, an integral part of the pump, provides minimum variation from set pressure and protects the unit against damage by accidental shut-offs in the discharge system.
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6. Blackmer rotary pumps supply the answer to a wide range of LIQUID MATERIALS HANDLING problems involving delivery to 1500 GPM — viscosities through 100,000 SSU — discharge pressures through 150 PSI — temperatures to 600°F.

liquid materials handling

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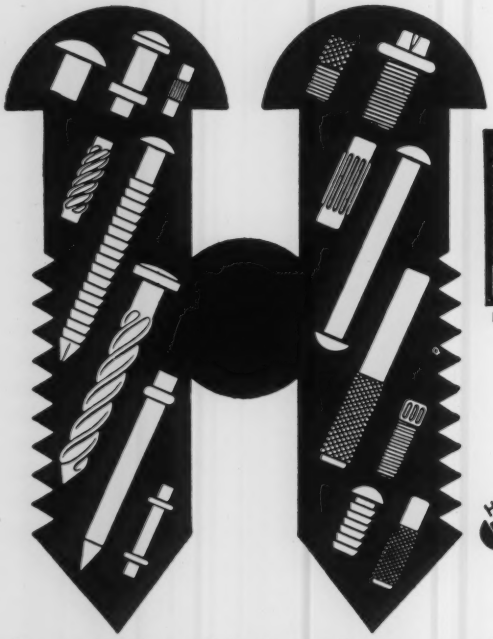
See Yellow pages for your local sales representative



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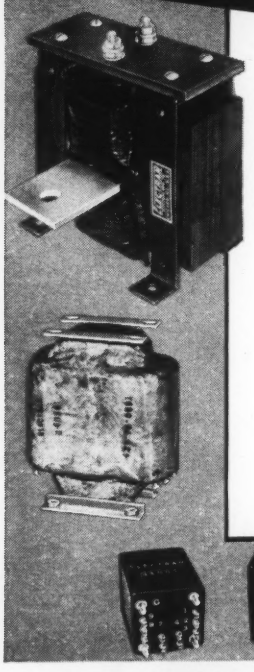
JOHN HASSALL INC.

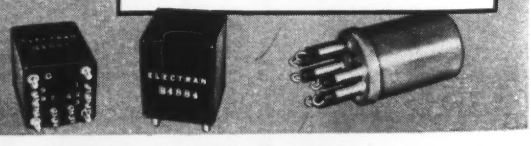
ELECTRAN *Transformers*



Transformers, Saturable Reactors, Chokes, Special Windings and Electronic Devices. Milliwatts to 50 KVA, single or polyphase in all frequencies.

Complete design and engineering service. All modern techniques, encapsulation, casting, military and commercial construction.

And, we've got one asset you'll find especially helpful: WE *TRY* HARDER!



Write for Bulletin 53 B

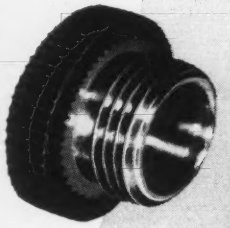
ELECTRAN MFG. CO.
1901 CLYBOURN AVENUE • CHICAGO 14, ILLINOIS

PHOENIX

BRUSH HOLDER CAPS

Phoenix can furnish brush holder caps for virtually any conceivable brush holder—and at prices most motor makers find less than their own manufacturing costs.

Send your cap print or a sketch for prompt quotation on uniformly accurate brush holder caps to meet your requirements—or ask for Bulletin containing full details on the complete "standard customized" line of Phoenix Brush Holders and Caps.

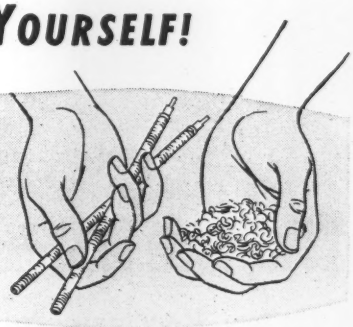


Write for Bulletin 54L

PHOENIX ELECTRIC MANUFACTURING CO.
711 West Lake Street Chicago 6, Illinois

PROVE TO YOURSELF!

INDUSTRIAL STACKED RETAINING RINGS



Speed Production Cut Costs

We GUARANTEE *faster* and *easier* assembly of open-type retaining rings . . . and less ring loss . . . with Industrial STACKED Retaining Rings. No more fumbling with tangled unstacked rings.

Try without risk. Full refund if Industrial's one-at-a-time modern dispensing does not reduce production costs. Industrial's specially designed base and tool are free with initial order. *Send today for new illustrated literature.*

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INDUSTRIAL RETAINING RING CO.
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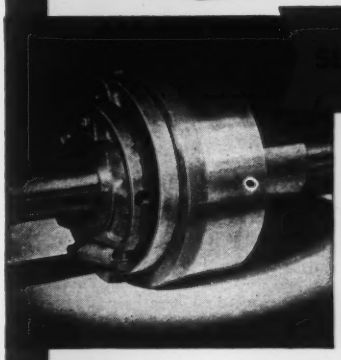
MOUNT VERNON 2, NEW YORK

HILLIARD

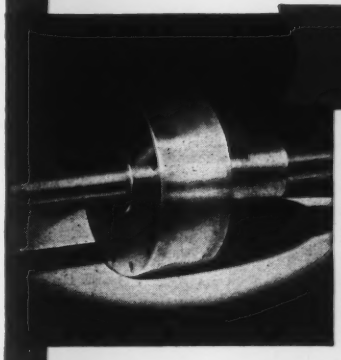
Clutches

FOR POWER CONTROL DESIGNS



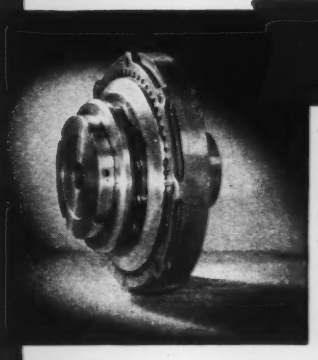
SINGLE REVOLUTION CLUTCH

Unequaled for accurate control of intermittent machine operations—cutting, punching and packaging. Gives closer tolerances to cut-off, stamping, shearing and similar machines. Completely automatic; manual, mechanical or electrical control.



OVER-RUNNING CLUTCH

Hilliard Over-Running Clutches and Couplings are automatic in operation. They are unsurpassed for automatic two-speed drives, dual drives, stand-by drives and for allowing machinery to "coast" after drive stops. Excellent as fixed or infinitely adjustable ratchets.



HILLIARD SLIP CLUTCH

A reliable series of spring-loaded slip clutches and couplings. Rugged construction with ample friction surface for heavy-duty use. Outstanding for preventing overloads and shocks; for starting heavy loads; as tension drag brakes; for reeling and winding operations and many other uses.

★ HILLIARD CLUTCHES and COUPLINGS make machine drive and power transmission more efficient and economical. Experienced engineers will be glad to offer their advice on any problems. Complete descriptive material will be furnished on request.

WRITE TODAY for our illustrated brochure #MP-4 for information.

CLUTCH MAKERS FOR OVER FORTY-FIVE YEARS

THE HILLIARD CORPORATION

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In Canada • • • **UPTON-BRADEEN-JAMES, LTD.**

A.C.M.I. BORESCOPES

for close-up visual inspection of internal surfaces and hidden parts

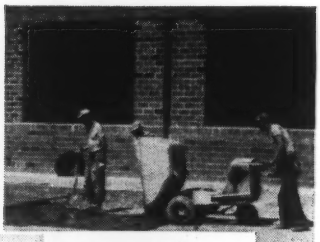
A.C.M.I. Borescopes are available in 4 angles of vision (as above)—in diameters of .120" to 4.00" —in lengths of 4" to 720". Special models for special problems.

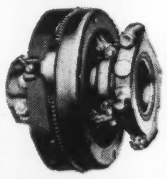
A.C.M.I. Borescopes permit close-up visual examination of interior areas and surfaces not otherwise visible. They save time and money, and prevent costly dismantling.* Each Borescope is a compact, self-illuminated industrial telescope of highest quality, employing a precision optical system, that produces a flat visual field. Lens systems are fully corrected for color, spherical aberrations, and coma, with all lens surfaces coated to increase light transmission

Write for free informational folder, or tell us your problem.

American Cystoscope Makers, Inc.
1241 LAFAYETTE AVENUE NEW YORK 59, N. Y.

HOW TO GET THE RIGHT CLUTCH





Whatever your power transmission control requirements may be, your product will benefit by using a clutch that is exactly suited to its need. Thousands of manufacturers — in hundreds of industries — have increased the efficiency of their machines with the right ROCKFORD CLUTCHES. Our engineers are not restricted to any one type or size of clutch — but are free to specify one that is best suited to the particular operating essentials of your product.

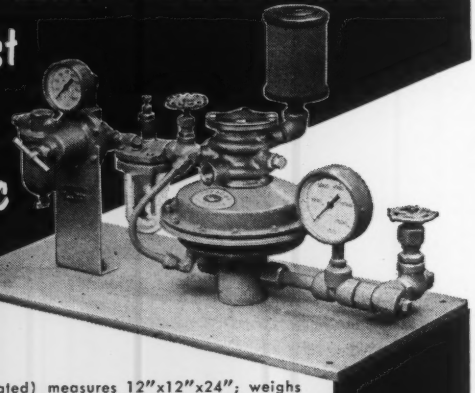
Write for our latest bulletin that shows typical installations of ROCKFORD CLUTCHES and POWER TAKE-OFFS, with diagrams of unique applications, capacity tables, dimensions and specifications.

ROCKFORD CLUTCH DIVISION
BORG-WARNER
311 Catherine Street, Rockford, Illinois

ROCKFORD CLUTCHES

POWER PACKAGES

Low Cost Portable Hydraulic



Model S-440 (illustrated) measures 12"x12"x24"; weighs 45 lbs. Contains air-operated pump, air muffler, air filter, air lubricator, air regulator, valves and gages and all necessary equipment for immediate operation.

Make just three connections and you are ready to boost 100 psi. plant supplied air pressure to 10,000 psi. fluid pressure for $278.25 (FOB Gardena, Calif.). Eight standard models for output fluid pressures of 1,000 to 30,000 psi. Special models for lower or higher pressures.

Applicable wherever low volume output at high pressures is the requirement. For oil or water service. Thousands in use. Send for bulletin No. 500.

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these rugged, compact, powerful Right-Angle Gear Units are sold locally through

The Star Machinery Co.

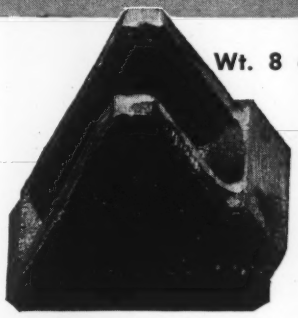
CROWN MITRE GEAR UNIT features:

- ★ Hardened "ZEROL" gears
- ★ Matched pairs of gears run in before assembly
- ★ Double shielded ball bearings throughout
- ★ Provision for re-lubrication if necessary
- ★ Choice of four or five mounting faces
- ★ High load capacity
- ★ Long service life
- ★ Compactly designed and rigidly constructed for guaranteed industrial service.

For complete information, engineering data and prices, consult one of the more than 120 Industrial Supply Distributors located in 42 states who are prepared to handle your Crown Gear requirements locally. There is One Near You!

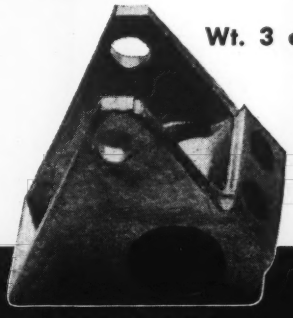
Crown Gear
320 Park Avenue
Worcester 10, Mass. U.S.A.

How THE ELECTRIC PRODUCTS CO. saved 33¢ on each Brass Brush-Holder Casting!



Wt. 8 oz.

PREVIOUS SAND-MOLD CASTING



Wt. 3 oz.

PRESENT BARNES PERMANENT-MOLD CASTING

The Electric Products Company of Cleveland, Ohio, nationally recognized for the high-quality and performance of its custom-built electric motors and generators, cut 33 cents from the cost of each of these No. 5 Baylis Brass Brush Holder Bodies — improved quality and appearance — by taking the simple and easy step of changing from the previously used sand-mold casting to a Barnes Permanent-Mold Casting!

Here's What They Accomplished by the Change:

1. Saved Extensive Milling and Sanding of Brush Holder!
2. Eliminated the Operation of Drilling 5 Holes!
3. Eliminated the Waste of 5 oz. of Scrap Metal from Each Casting!
4. Cut 50% from Cost of Shipping the Castings from Supplier to their Plant.
5. Doubled the Conductivity of the Brush Holder Due to the Denser, Finer Grain Structure of the Barnes Permanent-Mold Casting!
6. Improved the Appearance of the Assembled Motors and Generators!
7. Secured Similar Across-the-Board Savings When They Switched to Barnes Permanent-Mold Castings on Their No. 7 Holders!

You, Too, Can Save!

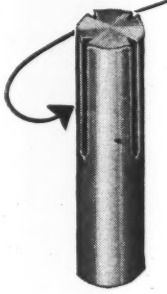
Whether it's brush holders or any other non-ferrous casting, Barnes Permanent-Mold Castings save hours of set-up time, thousands of dollars in machine time and labor! Don't overlook the possible savings to you! Send us your prints, today, for a cost estimate. You're under no obligation, of course.

Saving Thousands for Hundreds

BARNES PERMANENT-MOLD, INC.

MANSFIELD, OHIO

Perfect for Hinged parts



Here's a natural application for Driv-Lok Pins. Many satisfied customers are using them as hinge pins for doors, covers, guards and miscellaneous swinging or pivoted components of their products. Merely drill uniform hole, use pin with half-length grooves which lock in one part and permit free rotation of other part.

Each application suggests countless others. There are types and sizes of DRIV-LOK Pins to fit them all. Write for Catalog.

DRIV-LOK PIN COMPANY

715 Chauncey Street, Sycamore, Illinois

Low-priced WING NUT for light assemblies

Wing Type PALNUTS combine the convenience of finger tightening, with the security of spring steel locking action that defies vibration all at lower cost than ordinary wing nuts. Wing Type PALNUTS are available in #8-32, #10-32, #10-24, ¼-20 and 5/16-18 sizes, in choice of cadmium, nickel, chrome or other finishes to order

Send for free samples, prices and literature.

— —provides all these advantages at lower cost than plain wing nuts

- Built-in locking action that stays tight until finger released.
- Precision-made to accurately fit standard threads.
- Easy finger tightening or removal, due to ample wings.

WING TYPE PALNUT
TRADE MARK
LOCK NUTS
for quick, secure fastening at low cost

The PALNUT Company
75 Cordier St.,
Irvington 11, N. J.
In Canada:
P. L. Robertson Mfg. Co., Ltd.
Milton, Ontario

Increased Insulation

BETTER CONNECTIONS

JONES BARRIER TERMINAL STRIPS

Leakage path is increased—direct shorts from frayed terminal wires prevented by bakelite barriers placed between terminals. Binder screws and terminals brass, nickel-plated. Insulation, black molded bakelite. Finest construction. Add much to equipment's effect.

Jones Means Proven Quality

No. 2-142 No. 2-142-¾ W No. 2-142-Y

Illustrated: Screw Terminals—Screw and Solder Terminals—Screw Terminal above Panel with Solder Terminal below. Every type of connection.

Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

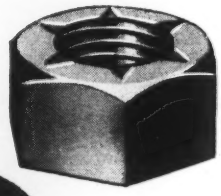
Catalog No. 20 lists complete line of Barrier Strips, and other Jones Electrical Connecting Devices. Send for your copy.

Jones HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

for easier

FASTER LOCKING

of threaded fasteners at lower cost!



The Gripco Lock Nut one-piece design gives a tighter more positive holding action for faster application at less cost. And for 50 years the Gripco locking feature has proven itself by an ever increasing use. All-one-piece to cut initial cost—(no inserts, outside devices or complicated features)—the extreme holding or locking action is produced by a simple, vertical thread deflection. For stress, wear or vibration, a Gripco Lock Nut will hold tighter, wear longer. Impervious to oil or water. Write for samples and full details.

GRIPCO PRODUCTS INCLUDE:

Gripco Lock Nuts, New Gripco "Clinch" Nuts, Gripco Hi-Nuts, Gripco Pilot-Projection and Countersunk Weld Nuts with or without Gripco locking feature.

103

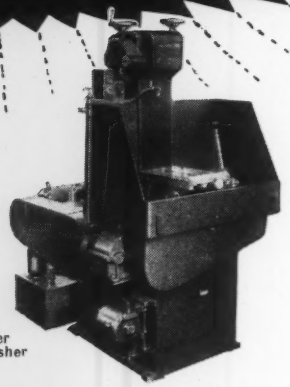
GRIP NUT COMPANY

"after 50 years still holding strong"

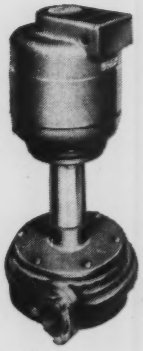
310-WS. MICHIGAN AVE., CHICAGO 4, ILL.

STARTS INSTANTANEOUSLY!

THE RUTHMAN **GUSHER** COOLANT PUMP



Illustrated is a Hammond 8" Model V-8WP Wet and Dry Abrasive Belt Grinder equipped with a Gusher Coolant pump.



With a Ruthman Gusher Coolant Pump you get plenty of coolant when you want it, *the instant the machine is turned on.* There is no priming necessary, Gusher Coolant pumps are always ready to go to work. Pre-lubricated heavy-duty ball bearings, electronically balanced rotating assembly, with no metal-to-metal contact within the pump, assure you of less maintenance care, longer life. Send for our illustrated catalog today.

THE RUTHMAN MACHINERY CO.

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Meet your wheel problems with "WHEELS by French & Hecht." Our experience, facilities and "Know-How" are your assurance of matured and tested recommendations—as well as wheel-hub-spindle-bearing assemblies perfectly suited to your requirements. In ONE engineered package, we offer you—

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DIVISION
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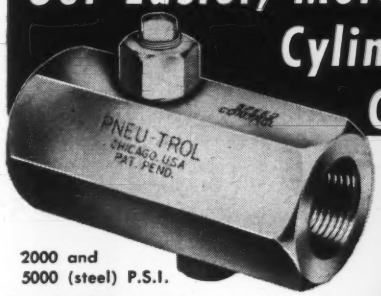
Get Easier, More Accurate Cylinder Speed Control



2000 and 5000 (steel) P.S.I.

with **Pneu-Trol** VALVES IN AIR OR HYDRAULIC USE

Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check Valve and Needle Valve incorporate single function features of Flow Control Valve. All valves available in 5 female pipe sizes — 1/8" to 3/4". Valve bodies are made from brass, aluminum, steel or stainless steel. Attractive Prices — Immediate Delivery.

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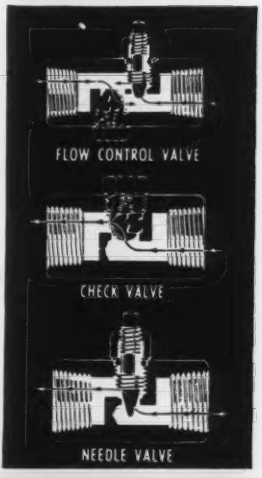
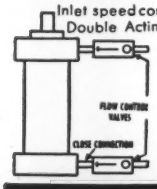
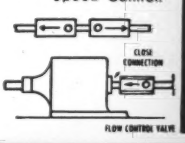


Inlet speed control for Double Acting Cylinder.



Single Acting Cylinder Speed Control.



Pneu-Trol Devices, Inc.
1436 N. Keating Ave., Chicago 51, Ill.

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Make it WORTHY Of Your Product

As the maker's "signature," your name plate is one thing that can set your product apart from all others. Make it *distinctive*, and let it reflect the quality you offer.

Let us help you create such a "signature." Our skilled craftsmen, long experience and modern equipment insure finest results. Send a rough sketch or blueprint for design suggestion and quotation.

Write now for "Etched or Lithographed Metal Products," with full color examples of name and instruction plates.

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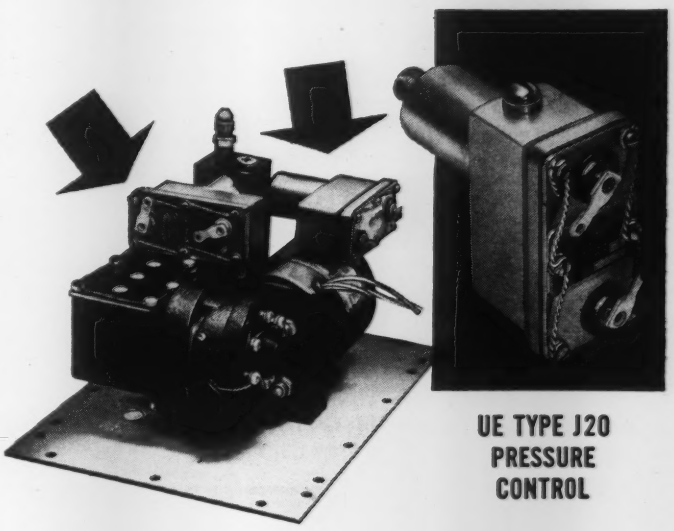
SUBSIDIARY OF DODGE MANUFACTURING CORPORATION, MISHAWAKA, INDIANA

UE PRESSURE CONTROLS MAINTAIN SET PRESSURES IN THE STRATOSPHERE



UE TYPE J20 PRESSURE CONTROL

The electronic equipment in today's high-flying aircraft requires uniform pressure conditions at predetermined levels in order to function accurately. At current operating altitudes, this pressure is supplied by pressurization units made by Eastern Industries, Inc. — and maintained by *UE* Type J20 controls.

The pressurization unit maintains a constant pressure at all times, between predetermined settings, thus assuring reliable performance of the plane's electronic equipment. The *UE* Type J20 Pressure Control automatically cuts the pressurization unit's motor in and out at those predetermined settings — thus assuring optimum electronic performance.

UE Type J20 — now offered commercially for the first time — is also being used in pressurized coaxial cables, R. C. A. ground radar, and in maintaining frequency bands.

United Electric manufactures a wide line of standard controls that are used in aircraft fuel purging systems, paper mill machinery, diesel engines, milk pasteurizers, room air conditioners and in countless other applications.

Special controls can be adapted from standard models, or can be custom built by United engineers working in cooperation with your own product development engineers.

Write today for information on the complete line of United Electric Controls.

Standard and special thermostats and pressure switches

UNITED ELECTRIC CONTROLS CO.
92 School Street, Watertown, Mass.

Now your EARS can "SEE" those hidden troubles

NEW MARSH
Serviceman Soundscope

. . . cuts servicing and maintenance costs

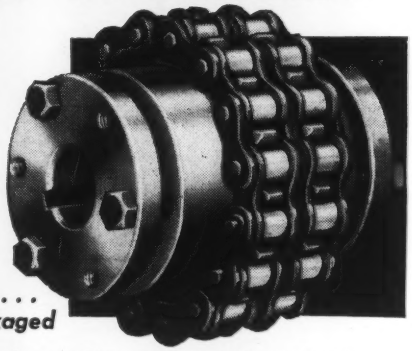
Most effective instrument ever developed for pin-pointing and identifying mechanical defects. Saves time and dollars tracking down troubles in bearings, gears, mechanisms . . . detects leaks, knocks, piston slaps—any defects that make a sound. A precision instrument of Marsh quality, sensitive to faintest sounds . . . with handy probe and headband as illustrated. A remarkable tool, moderately priced.

Ask for Circular

MARSH INSTRUMENT CO.
Sales affiliate of Jas. P. Marsh Corporation
Dept. B, Skokie, Illinois

Browning's NEW CHAIN COUPLING

STRONG AS THE SHAFT ITSELF!

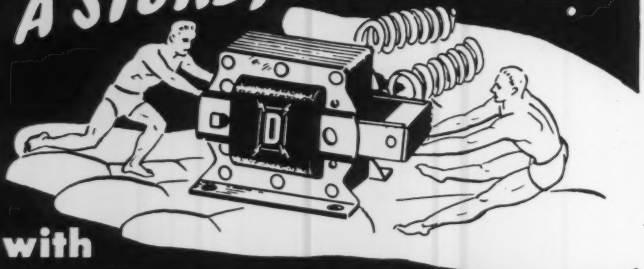


No reboring . . . simple assembly . . . individually packaged

Browning's chain coupling with pearlitic malleable sprockets, hardened teeth and standard roller chain provides maximum capacity and longer life. Employs same split taper compression bushing used in other Browning power transmission products. Strong as the shaft itself! Choice of 9 stock sizes, 38 bores from your Browning distributor. Ask him or write us for Catalog V169.

Browning MANUFACTURING COMPANY
MAYSVILLE, KENTUCKY

A STURDY SOLENOID!



with ENDURANCE PLUS!

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Approximately 17,000,000 cycles and continuing to operate as smoothly as the day it was installed! That's consistently the type of performance record which speaks for DORMEYER Machine Tool Solenoids.

These sturdily-built, long-life solenoids give trouble-free, efficient service for years. They are correctly engineered and precision-built from the best materials the market affords—and designed by our engineers for the particular application. Their sturdy design and careful construction enables them to give maximum service on the most difficult of industrial applications. Push-Pull, Push or Pull types.

Send in specifications for prompt estimate without obligation.

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FACTORIES IN CHICAGO AND KENTLAND, INDIANA
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conform to J. I. C. standards

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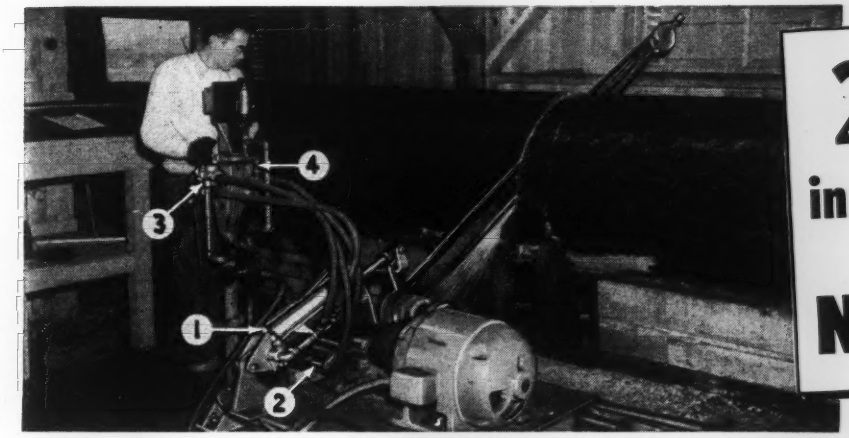
RUGGED BODY . . . all steel end caps and barrel.

PISTON RINGS . . . step-cut joint, long life, minimum leakage.

PRESSURE . . . 2,000 psi heavy-duty . . . 3,000 psi non-shock.

SIMPLICITY . . . no tie-rods . . . no retainer rings.

hydro-line Manufacturing Co.
5607 PIKE ROAD • ROCKFORD, ILLINOIS



2 Vital Movements in Deck Saw Operation *Powered by* NOPAK Cylinders

Arrow No. 1 — NOPAK 6"x14" Model E Cylinder
Arrow No. 2 — NOPAK 4"x10" Model E Cylinder
Arrow No. 3 and No. 4—NOPAK ½" 4-Way Valve

•

Refer to Sweet's File for Product Designers or write for Bulletin SW-2.

This carriage-type deck saw, designed and built by Elk Lumber Co. Medford, Ore., eliminates mis-cutting, and short logs reaching the carriage.

The 8 foot chain-saw bar is raised and lowered by a NOPAK Model E, 6" x 14" Air Cylinder. Horizontal carriage movement of 10", powered by a NOPAK 4"x10" Air Cylinder, permits operator to locate saw accurately to cut logs within minimum tolerance of ½". Both movements are controlled by NOPAK valves mounted at operator's station.

This is typical of hundreds of machine movements in which NOPAK Cylinders and Valves are used in all types of industry. For others, see the NOPAK Application Manual.

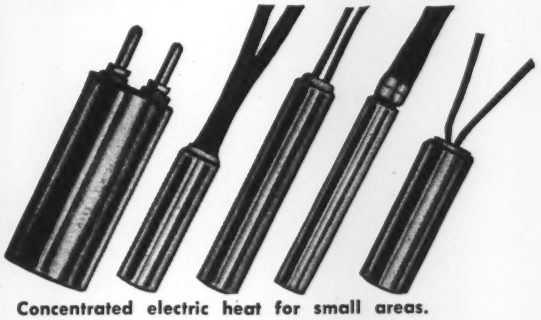
GALLAND-HENNING NOPAK DIVISION
2752 S. 31st STREET • MILWAUKEE 46, WISCONSIN

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE
Representatives in Principal Cities

A 7702-½-H

VULCAN
ELECTRIC HEATING UNITS

CARTRIDGE



Concentrated electric heat for small areas.

Brass sheath for temperatures up to about 750°. Other metals for higher temperatures.

Standard types and sizes listed in the Vulcan catalog: or size, sheath, terminals and lead wires adapted to your specific problems.

From years of experience our engineers can give you competent advice on electric heating problems.

VULCAN ELECTRIC COMPANY
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By the makers of Vulcan Electric Heating Units, Soldering Tools, Solder Pots, Glue Pots, Branding Irons and Electric Heating Devices.

Call in a Spring Specialist WHILE YOU DESIGN to save TIME • COSTS • FAILURES

While your product is in the design stage, we can make available to you our 35 years of Spring Engineering and Production Experience — a safeguard for you against production and performance failures. Properly designed and conscientiously manufactured springs will decrease your production costs, raise the efficiency of your product, and increase your customer satisfaction. We have the ability and organization to deliver such quality precision mechanical springs. Call or write us for any spring requirement.

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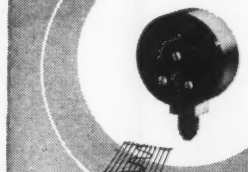
BOURNS MINIATURE GAGE PRESSURE POTENTIOMETERS

For Precise Pressure Reporting . . .

INDICATING—RECORDING—CONTROL



Designed for measuring pressure in aircraft, guided missiles and other equipment, BOURNS Gage Pressure Potentiometers are available in ranges from 0-100 psi to 0-5,000 psi. Actuated by the flexure of a Bourdon tube, these precision instruments have an electrical output which is linear with the applied pressure. Resolution of 0.4% and power of ½ watt are obtainable in a wide variety of resistances.

Though miniature in size and light in weight, BOURNS Gage Pressure Potentiometers are extremely rugged and accurate. A ball bearing supported linkage system transmits the movement of the Bourdon tube to the sliding contact. Instruments are not damaged by shock, vibration or nominal over-pressure.

BOURNS designs and manufactures other precision potentiometers for measuring position, differential pressure, absolute pressure, altitude and acceleration.

BOURNS is also, the creator and exclusive manufacturer of the *TRIMPOT*

BOURNS LABORATORIES

6135 Magnolia Avenue, Riverside, California

Technical Bulletin on request, Dept. 193

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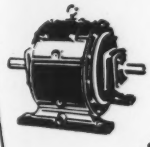

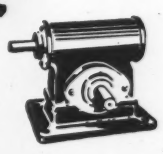

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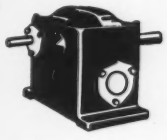

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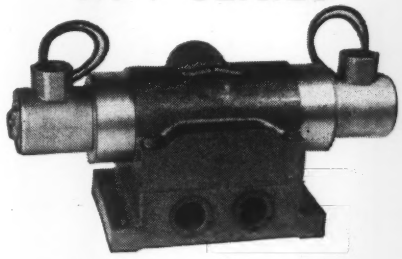

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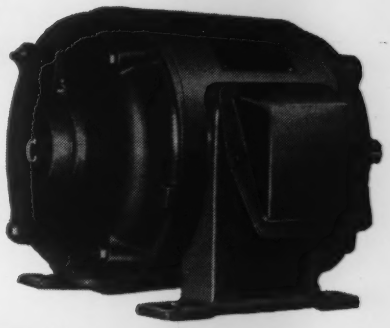
NEW Century Performance-Rated® INTEGRAL H.P. MOTORS



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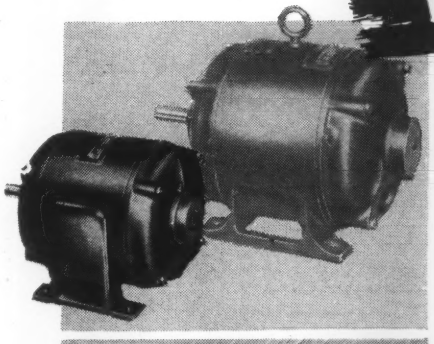

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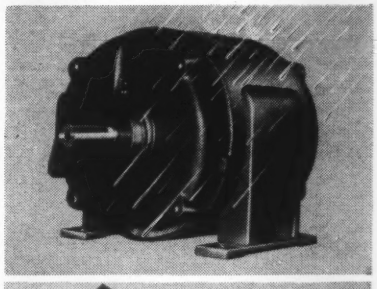

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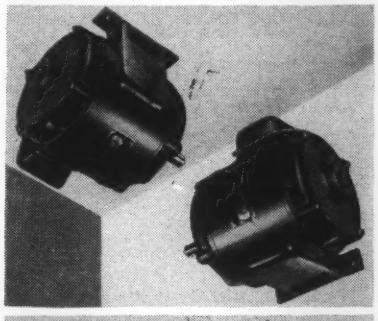

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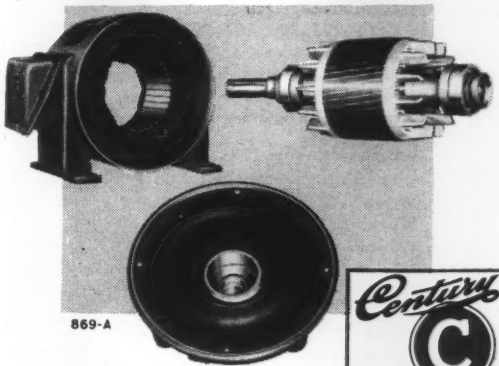

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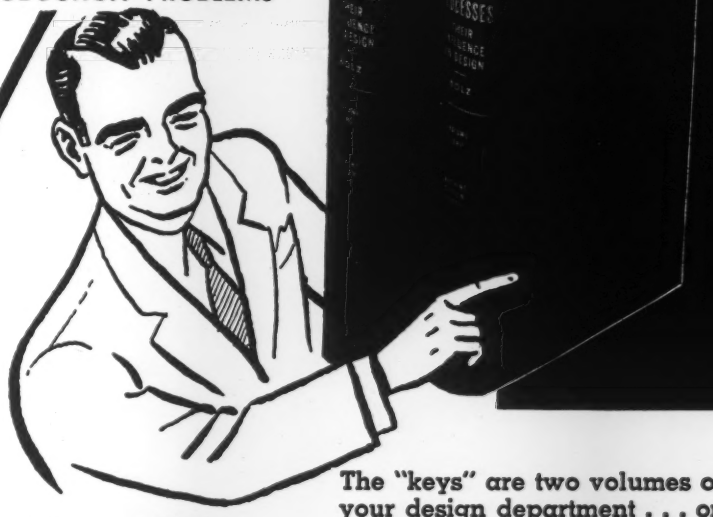

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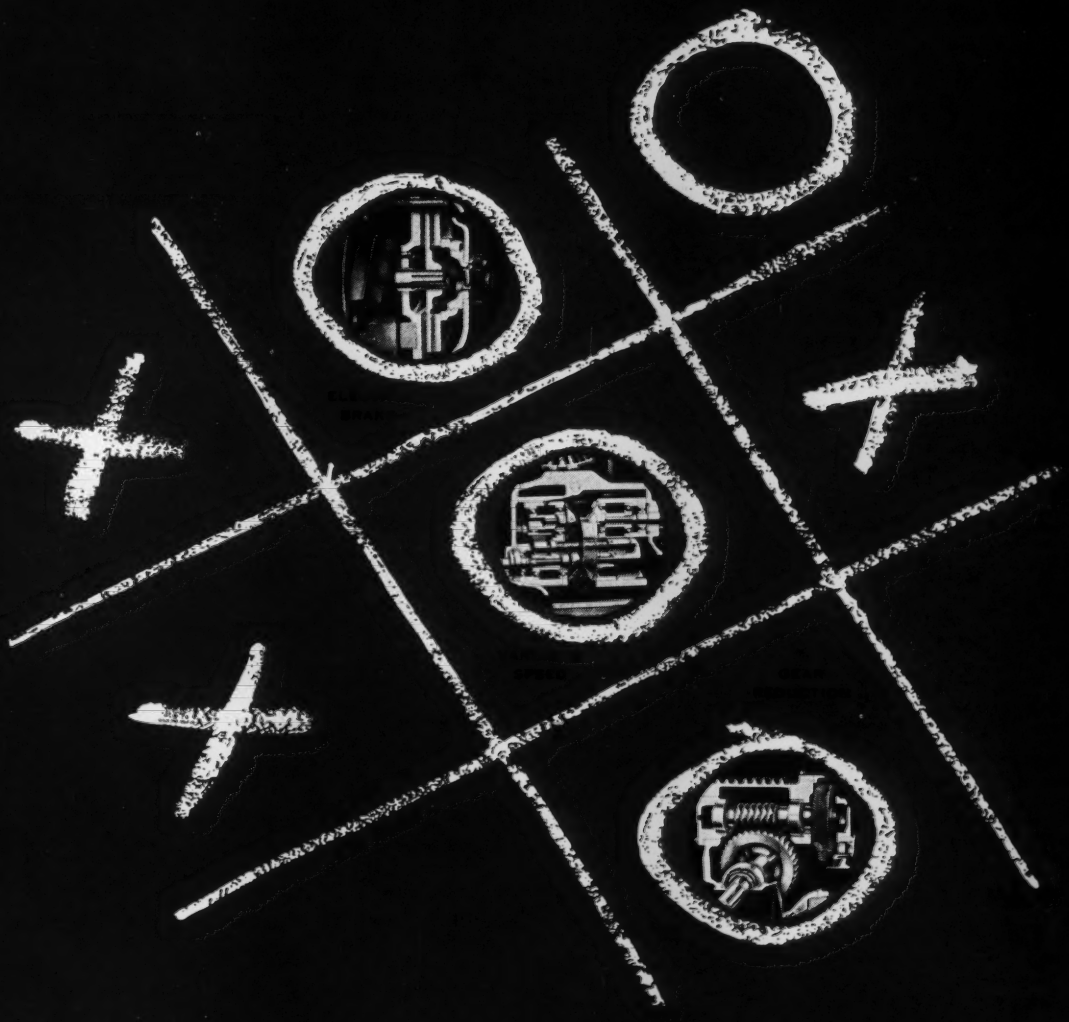

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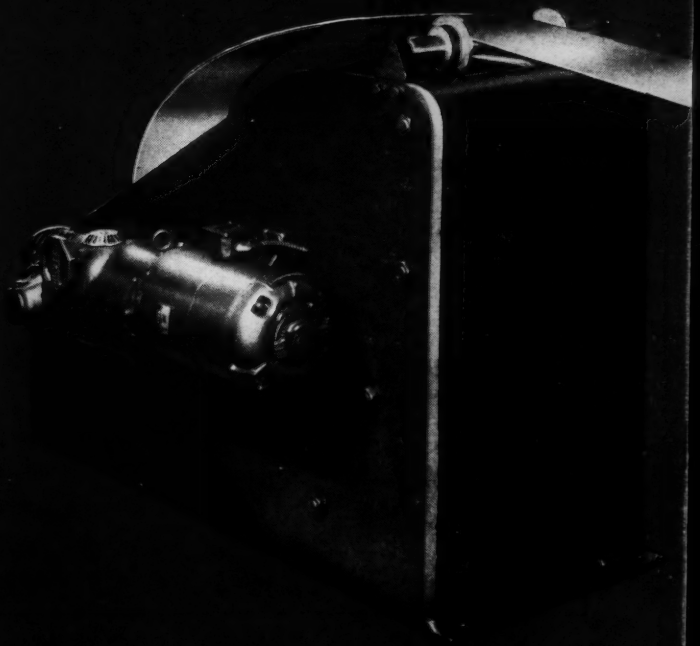

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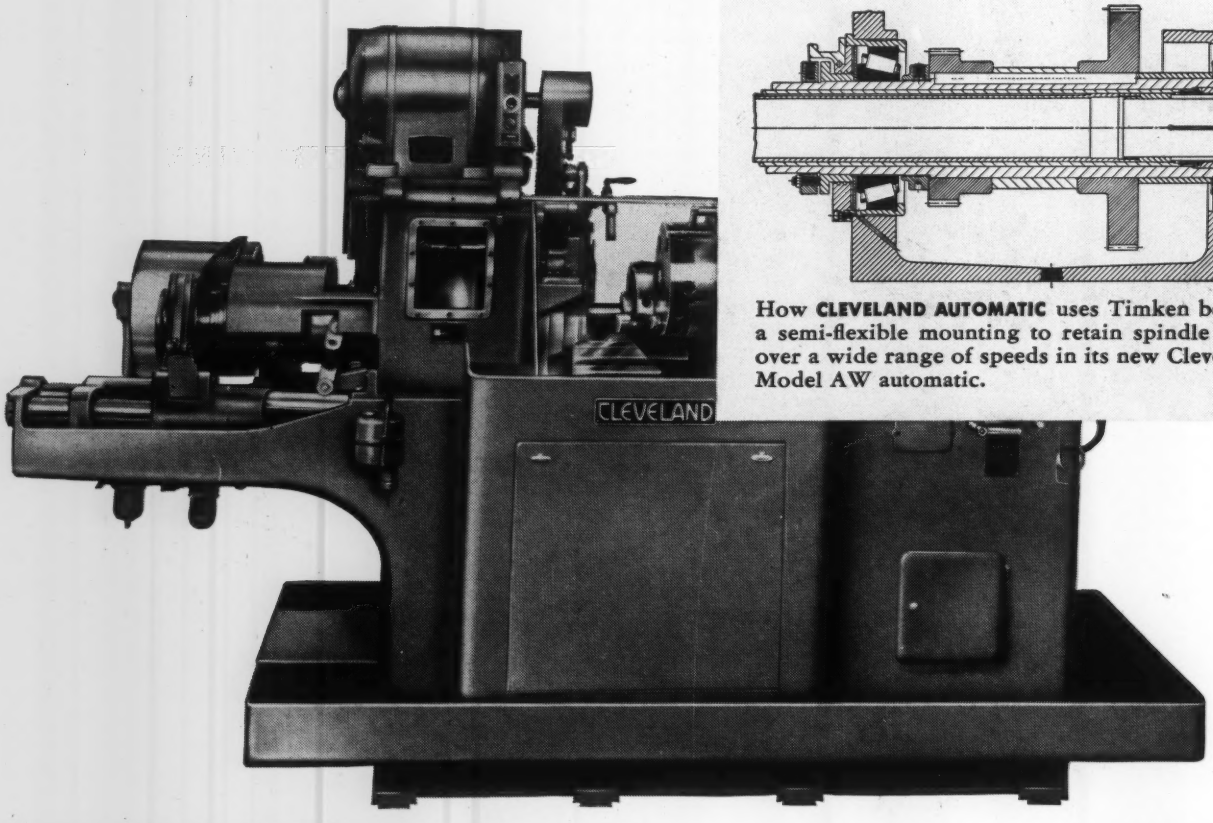

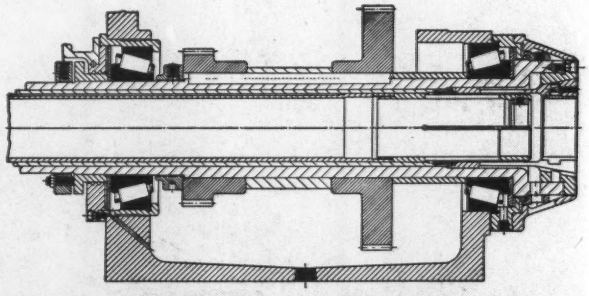

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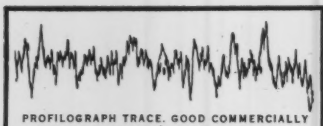

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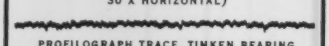

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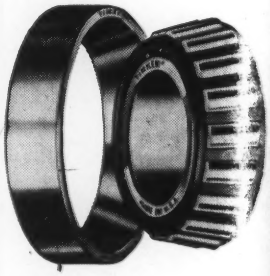

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